AD-A172 901 ENERGY ABSORPTION OF POLYURETHANE BASED POLOYMER ALLOYS 1/2
(U) DETROIT UNIV MI POLYMER INST I RAZA ET AL
15 SEP 86 ARO-22361 2-MS DAAG25-85-K-0129

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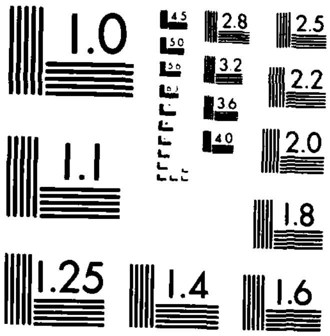

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: ARO 22361.2-MS
2. GOVT ACCESSION NO.: N/A
3. RECIPIENT'S CATALOG NUMBER: N/A
4. TITLE (and Subtitle): Energy Absorption of Polyurethane-Based Polymer Alloys
5. TYPE OF REPORT & PERIOD COVERED: Interim Technical 1/1/86 - 8/15/86
6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): I. Raza, B. Muni, B. Sedghi, D. Klempner and K. C. Frisch
8. CONTRACT OR GRANT NUMBER(s): DAAG 25-85-K0129
9. PERFORMING ORGANIZATION NAME AND ADDRESS: University of Detroit Polymer Institute, 4001 W. Mc Nichols Detroit, MI 48221
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Research Office, Post Office Box 12211, Research Triangle Park, NC 27709
12. REPORT DATE: September 15, 1986
13. NUMBER OF PAGES: 141
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)
15. SECURITY CLASS. (of this report): Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report): Approved for public release; distribution unlimited.

DTIC ELECTE OCT 1 0 1986 S A

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report): NA
18. SUPPLEMENTARY NOTES: The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.
19. KEY WORDS (Continue on reverse side if necessary and identify by block number): Interpenetrating polymer network (IPN), Morphology, Polyurethane, Epoxy, Elastomer, Foam, Sound Attenuation, Filler, Graphite, Plasticizer, Energy Absorption, Dynamic Mechanial Test, Tan , Tg, Post-cured, Random Batch Mixing, Rebound, Tensile Strength, Compression, Elongation, Thermomechanical Analysis.
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Interpenetrating polymer networks (IPNs) elastomers and foams composed of polyurethanes and epoxies were prepared by the simultaneous technique. Fillers and plasticizers were incorporated by random batch mixing. The PU/epoxy ratio was varied. Enhanced energy absorbing abilities were demonstrated by the dynamic mechanical spectroscopy results (broad and high tan δ behavior as a function of temperature). This was reflected in the mechanical and acoustical energy absorption of the foams. The effects of fillers and plasticizers were mixed.

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86-10-7-200

INTERIM TECHNICAL REPORT

ENERGY ABSORPTION OF POLYURETHANE BASED POLYMER ALLOYS

GRANT NUMBER: DAAG 25-85-K-0129

Polymer Institute

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September, 1986

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I. INTRODUCTION AND OBJECTIVES

The objective of this study is to develop interpenetrating polymer network (IPN) elastomers and foams which exhibit good sound and mechanical energy attenuation characteristics over a broad frequency and temperature range. In this study the effect of various plasticizers and fillers was investigated. The effect of post-curing on the dynamic mechanical properties (tan δ) of IPN elastomers was also studied. IPN foams were prepared with different levels of epoxy, fillers and plasticizers. The sound absorption was measured by the impedance tube method.

II. EXPERIMENTAL

A. Materials

The materials used in this study are summarized in Table I. The polyols, chain extenders, and epoxy resin were degassed under vacuum at 70°C for 24 hours. The other chemicals were used as received from the manufacturers.

B. Preparation of Samples

1. IPN Elastomers

The IPN elastomers based on polyurethane and epoxy and pure polyurethane were prepared by the simultaneous polymerization technique. The pure polyurethane system contained polyols (Niax 31-28), chain extender (Isonol-100), urethane catalyst (T-12), isocyanate (Isonate 143L) and various plasticizers.

The components were mixed together for one minute at room temperature using a high speed mechanical stirrer. The mixture was then poured into a pre-

heated mold and pressed on a laboratory platen press at $100^{o}C$. The samples were then removed from the press (after curing for 30 minutes) and then post-cured in an oven at $100^{o}C$ for 16 hours. Samples were conditioned at $25^{o}C$ and 50% relative humidity for at least three days prior to testing.

2. IPN Foams

IPN and 100% polyurethane foams were prepared by the one-shot, free-rise method. The chemicals were used at room temperature (RT) as received except for DER 330 and 1,4-BD which were degassed. All the reactants and blowing agents were measured and well mixed in a cup. Then the isocyanate and catalysts were added to the cup and thoroughly mixed with a high speed stirrer. The cream time, rise time, and tack-free time were recorded in seconds. The foams were cured at $100^{o}C$ for one hour and conditioned at $25^{o}C$ and 50% relative humidity for at least three days prior to testing.

C. <u>Testing</u>

1. Dynamic Mechanical Spectroscopy

All dynamic mechanical measurements were conducted on a Rheovibron dynamic viscoelastometer, DDVII (Toyo Manufacturing Co.) at a scanning rate of 1 to $2^{o}C$ per minute in the glass transition region or every 3 to $5^{o}C$ per minute in the non-transition region. The specimens were in the form of rectangular films with dimensions of 2 cm in length, 0.1 cm in width, and 0.05 cm in thickness. The specimens were inserted into the chamber and cooled to $-50^{o}C$ where the measurements began. All tests were carried out at a frequency of 110 Hz.

The height of tan δ as reported in Tables 6 and 7 is the height at which the maximum tan δ is obtained, and the temperature at the peak is the point at which the maximum tan δ is obtained, and is the glass transition temperature, Tg.

The area under the curve was calculated by Simpson's method. The area considered is under the tan δ curve and is calculated by taking into account all the tan δ points, from the beginning to the end of the transition.

Thermo-mechanical analysis was also conducted on the samples using the TMS-2 Thermo-Mechanical Analyzer. The peaks were recorded and are reported in Tables 9 and 10.

2. Standing Wave Apparatus (Bruel & Kjaer, Type 4002) for Sound Absorption Measurement

This apparatus (Type 4002) is designed for easy and quick determination of the absorption coefficient of acoustic materials by the standing wave method. The advantages of the method are that only small circular samples, about 10 cm in diameter, are needed. The principal of the measurement method is shown in Figure A. The loudspeaker at one end of the tube is operated at the desired test frequency from an audio-frequency oscillator with 6 ohms output impedance and a distortion of less than 1% (B.F. Oscillator Type 1022). The sound waves move through the tube and strike the sample which is placed in a sample holder with a thick back plate, to avoid all sound absorption by the apparatus itself. The sound waves are then partly reflected at the sample. The resultant of the incident wave with amplitude 1 and reflected wave with amplitude r is a standing wave pattern with alternate sound maxima 1 + r and minima 1-r in the tube. From the ratio n of these sound pressure maxima and minima the reflection coefficient r (see equation below) follows directly:

$$r = \frac{n-1}{n+1} \qquad (1)$$

However, we are interested in the absorption coefficient α, i.e. the ratio of

the energy absorbed by the sample to the incident energy. In other words, $\alpha = 1-r^2$, from which, with the aid of the relation (1):

$$\alpha = \frac{4}{n + \frac{1}{n} + 2} \quad (2)$$

The sound field is explored by means of a probe microphone, movable on a track equipped with a scale on which the exact distance between the probe entrance and test sample can be read. The microphone voltage is amplified by a selective amplifier to reduce the influence of hum and noise and higher harmonics, which are inevitably generated by the speaker in the tube. Particularly suitable for this purpose is the 1/2 Octave Analyzer 2112 with 33 fixed filters from 22 Hz to 45 kHz and three scales, 0-100%, 0-70%, and 0-30%.

The absorption coefficient is determined by the tube measurement method only at normal incidence, which is why the measured coefficients are generally somewhat smaller than those determined by the reverberation room method according to W.C. Sabine's formula.

3. Density

The density of foam samples was measured according to ASTM D-1622.

4. Compression, Tensile Strength, and Elongation

The compression, tensile strength, and elongation were measured on an Instron Universal Tester according to ASTM D-3574, Test C and Test E, respectively. The hysteresis curves were also obtained on the Instron at 2.0 mm/s. The area bounded by the two curves is the total energy absorbed. The hysteresis values are the ratio of energy absorbed to the total energy given to the sample.

5. Bashore Rebound

The Bashore rebound test was measured according to ASTM D-3574, Test H.

III. RESULTS AND DISCUSSION

A. Effect of Plasticizers on Pure Polyurethane System

The effect of various plasticizers on the morphology as determined by (tan δ) behavior of pure polyurethane system was investigated. The pure polyurethane system selected as a model formulation is labelled as Formulation #1 in this report (see Table 3).

Plasticizers such as tricresyl phosphate (TCP) resulted in very high tan δ values, and in low amounts has led to a broadening of the temperature range of the transition. The area under the tan δ curve always increased with increasing amount of plasticizers (see Table 6). The glass transition temperature (Tg) decreased, as expected (see Figures 2 and 3).

Santicizer 141 also led to an increase in tan δ as the amount of Santicizer 141 increased, but the temperature range remained the same. The Tg decreased also (see Figures 4 and 5).

Santicizer 160, Benzoflex 988, and Stan Flux LV also resulted in higher and broader tan δ values with the Tg again at lower temperature (see Figs. 6-8).

Higher amounts (8%) of chain extender, Isonol-100, utilized in elastomers with 20 and 50% Santicizer 141 as plasticizer, led to a decrease in tan δ height with an increase in the temperature range. The Tg also was correspondingly higher, as expected, due to more hard segments (see Figs. 9 and 10).

Further analysis of the above interactions may be obtained by studying the solubility parameters of the polymers and the plasticizers. Solubility parameters provide a measure of the extent of interaction possible between chemical species. To determine the solubility parameter, the structure of the smallest repeat unit was considered and the contribution of each atomic group to the total energy of vaporation and molar volume was summed over the molecular structure. The ratio is calculated as the cohesive energy density and the square root is

taken as the solubility parameter. The calculated solubility parameters of the polymers and plasticizers are shown in Table 2.

It has been noted during the study that as the solubility parameter of various plasticizers approach those of the polyurethane group, the height of tan δ and the temperature range broadens. Santicizer 160 and tricresyl phosphate (TCP) which have similar, high solubility parameters, and Benzoflex 988 which has an even higher value, led to a broadening of the temperature range and a high tan δ value to result in the greatest area under the tan δ curve. Santicizer 141 and Stan Flux LV, which had the lowest solubility parameter, resulted in the least enhanced height and broadness of the tan δ peak.

B. Interpenetrating Polymer Networks (IPNs)

The effects of IPN formation with epoxy were to greatly broaden the tan δ peak and shift it to around room temperature. This is, of course, due to the interpenetrating effect resulting in a semi-miscible morphology. The height of the tan δ peaks decreased. The overall area under the tan δ curve increased with epoxy content, indicating the enhancement in energy absorbing potential of these IPNs.

In the case of pure polyurethane, the glass transition temperature (Tg) is much below room temperature, but it has shifted by as much as 30°C in the case of IPN elastomers (too close to RT-the desired location for optimum energy absorption over broad temperature and frequency ranges).

Plasticizers helped in obtaining very high tan δ values and a broad temperature range in some cases with the pure polyurethane system. However, the same cannot be said about the IPN elastomers. The temperature range has narrowed, though a slight increase in tan δ value was obtained. No relation between the solubility parameters of the polymers and the plasticizers could be found regarding tan δ behavior.

The effects of various plasticizers on the morphology as noted approximately by tan δ behavior of IPN elastomers were investigated. The PU/epoxy IPN elastomer (Formulation #1 in the previous report), 60/40 with 2% Isonol-100 as a chain extender, was selected as the basic PU formulation (labelled as Formulation #11 in this report). This formulation was repeated to check the reproducibility and consistency of the preparation. The result is shown in Figure 11 (the result indicates the reproducibility of the previous work).

The plasticizers used were Benzoflex 988, Santicizer 141, 148, 160, Stan Flux LV, and tricresyl phosphate (TCP) in various preparations in the PU/epoxy IPN.

It has been found that the higher level of Benzoflex 988 definitely increases the tan δ height but it narrows the temperature range. However, with low amounts of graphite filler, it slightly broadens the temperature range. This behavior is shown in Table 7B and in Figures 12 to 15. A shift in Tg by $\sim 10^{o}$ was observed with the increased level of Benzoflex 988.

In the case of Santicizer 141, higher level of plasticizers does not really effect the tan δ height or the temperature range, as shown in Table 7C and in Figures 16 and 17.

In the case of Santicizer 148, the higher level of plasticizer increases the tan δ height but narrows the temperature range considerably. This is shown in Table 7C and in Figures 18 and 19.

In the case of Santicizer 160, it has been observed that higher level of plasticizer increases tan δ height but it is accompanied by reduced temperature range. In addition, considerable shift in Tg ($\cong 25^{o}C$) was observed. This is shown in Table 7D and in Figures 20 and 21.

In the case of Stan Flux LV, the lower level of plasticizer gives very good tan δ height and temperature range also. This behavior is shown in Table 7D and in Figures 22 and 23.

In the case of TCP, neither higher nor lower levels of plasticizer helped in either increasing tan δ height or the temperature range. This behavior is shown in Table 7E and in Figures 24 and 25.

C. Effect of Chain Extender Isonol-100

In an attempt to study the effect of change in the level of Isonol-100, it was observed that higher levels of Isonol-100 decreased the tan δ height but broadened the temperature range, as shown in Figure 27.

D. Effect of PU/Epoxy Ratio

In order to study the effect of the PU/epoxy ratio, IPN elastomers with different PU/epoxy ratios (50/50 and 40/60) were made using Benzoflex 988 and Santicizer 160. The results indicate that in both cases higher tan δ is obtained as compared to the PU/epoxy ratio of 60/40. However, with 30% Benzoflex 988, the PU/epoxy ratio of 40/60 yields higher tan δ and broader temperature range while with Santicizer 160 the temperature range obtained is narrower. The results are shown in Table 7F and in Figures 28 to 33.

E. Effect of Post-Curing

During our study of the viscoelastic properties of various IPN elastomers as shown in Table 4, it has been found that for a given IPN elastomer, lower amounts of post-curing result in tan δ values which are considerably higher and somewhat broader than that of the fully post-cured elastomer sample.

The high tan δ values of the samples without post-curing or low post-curing time (See Table 7G and Figures 34-43) were probably due primarily to

the unused epoxy. The molecular chains are partially loosening and the small chain segments can move, i.e. the epoxy acts somewhat as a crosslinked plasticizer. In order to investigate the above phenomena, THF (tetrahydrofuran) extraction of uncured reference IPN elastomers was carried out on samples ranging from no post-cure to 2, 4, 8, and 16 hours of post cure.

The samples were extracted for 24 hours, followed by vacuum drying at 66°C for 24 hours and were conditioned at 25°C and 50% relative humidity for at least three days prior to testing. The results are shown in Figures 44 to 49. It indicates that the epoxy has gelled within the mold, i.e. not much was extracted (see weight loss results in Table 8).

The following observations made be made from Figures 44 to 49:

1) The weight loss after the extraction decreased as the time of post-curing increased.

2) For the sample with no post-cure and two hours post-cure, the tan δ results are unusual below 0°C (multiple peaks), where as for 4, 8, and 16 hours post-cured samples, the unusual results are below -20°C.

3) For almost all the samples, the maximum height of tan δ and the temperature range do not vary considerably.

The results obtained are quite interesting and require futher investigation.

F. Discussion

Since difficulties arose pertaining to collapsing and shrinkage of the foams, as mentioned in the previous reports and necessitated preheating the reactants, a series of experiments was conducted on the amount of water existing in the foams as blowing agent. This amount was varied in different formulations according to different levels of epoxy and fillers to result in

desirable foams (no collapsing or shrinkage of the foams without preheating the reactants, as was necessary in the previous studies).

IPN foams were then prepared with PU/epoxy ratios of 90/10, 80/20, 70/30, 60/40, and 50/50. Different levels of fillers, such as graphite and rubber powder, were introduced into the IPN foams at different levels and various PU/epoxy ratios. Figures 50-52 show the effects of the PU/epoxy ratio for different fillers at different levels on the sound absorption. Figures 53-55 also show the effects of graphite for different PU/epoxy ratios on the sound absorption. The total energy absorbed at lower frequencies (0-500 Hz), higher frequencies (500-8000 Hz) and the whole range of frequencies (0-8000 Hz) was calculated from the areas under the sound absorption curves (bar charts). A cutoff at 500 Hz was made because this seems to be where most of the foams experienced a quantum jump in sound absorption. The acoustical energy absorbed at each range of frequencies was compared to each other in the form of relative deviation within that frequency range. Therefore, it is not advisable to compare the plots of different frequency ranges because of the scattered nature of the data. Simply compare behavior of each system within each of the ranges. The least-squares method was used to lump all the information available onto a linear curve. This would show trends as to how the properties of the foams are affected. Figure 50 indicates that at the lower frequencies, addition of the epoxy improves the sound absorption at all levels of graphite and rubber powder. This, however, is not true at the higher frequencies (see Figure 51). Notice that addition of epoxy improves the sound absorption of the sample without any fillers added at both lower and higher frequency ranges. Figure 53 shows that the samples with PU/epoxy ratios of 70/30 and 80/20 have positive reaction to higher levels of graphite at lower

frequencies. At higher frequencies, the 80/20 sample still has an upward slope with increasing graphite while the 70/30 sample almost stays unaffected (see Figure 54).

The effects of plasticizers were studied on IPN foams with PU/epoxy ratios of 90/10 and 70/30. Each plasticizer was used at 20% by weight. Higher amounts could not be used due to foam collapse (crosslinking reduced too much). It can be seen from Figure 56 that Stan Flux LV improved the sound absorption at both the lower and the higher frequencies for the PU/ epoxy ratio of 90/10. Santicizer 148 and 160 had a large impact on the samples at the higher frequencies. However, they lowered the sound absorption at the lower frequencies. Santicizer 160 improved the sound absorption of the IPN foam with the PU/epoxy ratio of 70/30 at both the lower and the higher frequencies (see Figure 57). Benzoflex 988 and Santicizer 148, however, lowered the sound absorption at the lower frequencies.

Other foam properties such as compression, tensile strength, rebound and hysteresis, were measured for the foam samples. The effect of graphite on stress at 50% compression of the samples may be seen from Figure 58, where graphite slightly improved the 70/30 IPN foam and lowered the compression at 60/40. The properties of the rest of the PU/epoxy ratios were almost unchanged by graphite addition. The tensile strength properties of the IPN and PU foams were lowered as a result of increasing the graphite (see Figure 59). This most likely is due to the presence of the foreign material in the samples which disturbs the crosslinking of the foams to result in the lower tensile strength properties. The presence of the graphite also slightly improved the hysteresis properties (see Figure 60). As the ratio of the epoxy increases in the IPN foams, a decrease in stress at 50% compression occurs

in the presence of fillers. However, foams without graphite and rubber powder showed an upward slope (see Figure 61). The tensile strength properties were lowered as the concentration of the epoxy was increased (Figure 62). The most dramatic effects of IPN formation on the energy absorbing abilities of these foams occured in the mechanical energy absorption measurements, i.e. rebound and hysteresis (see Figures 63-64). As expoxy increases, rebound decreases significantly while hysteresis increases. Both these results demonstate the enhancement in energy absorption due to IPN formation.

The mechanical properties of IPN 90/10 and 70/30 are shown in Figures 65-68, with different plasticizers introduced into the foams. Figure 65 shows that the stress at 50% compression was lowered by introducing Santicizer 160, Benzoflex and Stan Flux LV. The hysteresis and tensile strength have also dropped in the presence of plasticizers (Figures 66 and 67 respectively). Introducing the plasticizers has lowered the rebound values as expected (Fig. 68).

In order to determine the effects of density and cell structure on the sound absorption of these foams, foams with varying amounts of Freon (PY/epoxy= 70/30) and varying ratios of surfactants prepared (Figures 69-71 and Figures 72-74). As can be seen, increasing density resulted in increased sound absorption, especially at lower frequencies. Coarser cell structure resulted in enhanced sound absorption, especially at higher frequencies.

IV Future Work

Three component IPN's will be studied.

TABLE I

Materials

Materials	Chemical Composition	Eq. Wt.	Supplier
Isonate 143L	Carbodiimide modified diphenylmethane diisocyanate	143	Dow Chemical Co.
Niax 31-28	Graft copolymer of poly(oxypropylene)(oxyethylene) adduct of glycerol	2004.5	Union Carbide
Isonol 100	N,N'-Bis(2-hydroxypropyl) aniline	104.5	Dow Chemical Co.
DER 330	Bisphenol A-epichlorohydrin epoxy resin	177 - 178	Dow Chemical Co.
T-12	Dibutyltin dilaurate		M&T Chemical
Niax A-1	70% Bis(2-dimethylaminoethyl) ether solution in dipropylene glycol		Union Carbide
$BF_3(OC_2H_5)_2$	Boron triflorine etherate		Eastman Chemical
DMP-30	2,4,6-Tris(dimethylamino methyl) phenol		Rohm & Haas
XU-213	BCl_3-amine complex		Ciba-Geigy
Freon 11A	Trichlorofluoromethane		E.I. du Pont
DC 193	Silicone copolymer surfactant		Dow Corning
L-540	Silicone surfactant		Union Carbide
L-5303	Silicone surfactant		Union Carbide
L-548	Silicone surfactant		Union Carbide
1,4BD	1,4 Butanediol	45	
Powder	Rubber powder		
Santicizer 141	2-Ethylhexyl diphenyl phosphate		Monsanto
Santicizer 148	Isodecyl diphenyl phosphate		Monsanto
Santicizer 160	Butyl benzyl phthalate		Monsanto
Stan Flux LV	Aromatic processing oil		Harwick Chemical Corp.
Benzoflex 988			Velsicol Chemical
TCP	Tricresyl phosphate		C.P. Hall Co.
Graphite flake #2	Size: -50 mesh + 200 mesh		Asbury Graphite Mills, Inc
Graphite flake #3	Size: -80 mesh down		Asbury Graphite Mills, Inc

TABLE 2. SOLUBILITY PARAMETER OF VARIOUS COMPONENTS AND PLASTICIZERS

Components	Solubility Parameter (Hildebrand)
Isonate 143L (Isocyanate)	10.69
Niax 31-28 (polyol	11.23
Isonol 100 (chain extender)	11.64
DER 330 (epoxy resin)	10.61
Plasticizers	
TCP	9.0
Santicizer 141	8.6
Santicizer 148	8.56
Santicizer 160	9.28
Benzoflex 9-88	11.87

Table 3. Formulation of Pure Polyurethane System

Figure No.	1	2	3	4	5	6	7	8	9	10
Sample No.	1	2	3	4	5	6	7	8	9	10
Polyurethane										
Isonate 143L, g	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	10.87	10.87
Niax 31-28, g	62.24	62.24	62.24	62.24	62.24	62.24	62.24	62.24	54.40	54.40
Isonal 100, g	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	4.73	4.73
T-12, g	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Plasticizers										
TCP, g	-	14	35	-	-	-	-	-	-	-
Santicizer 141, g	-	-	-	14	35	-	-	-	14	35
Santicizer 160, g	-	-	-	-	-	14	-	-	-	-
Benzoflex 988, g	-	-	-	-	-	-	14	-	-	-
Stan Flux LV, g	-	-	-	-	-	-	-	14	-	-

Table 4A. Formulation of Polyurethane/Epoxy IPN Elastomers

Sample No.	11	12	13	14	15	16	17
Polyurethane							
Isonate 143L, g	3.89	3.89	3.89	3.89	3.89	3.89	3.89
Niax 31-28, g	37.35	37.35	37.35	37.35	37.35	37.35	37.35
Isonol 100, g	0.76	0.76	0.76	0.76	0.76	0.76	0.76
T-12, g	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Epoxy							
DER 330, g	28	28	28	28	28	28	28
BF_3-etherate, g	0.6	0.6	0.6	0.6	0.6	0.6	0.6
PU/Epoxy ratio	60/40	60/40	60/40	60/40	60/40	60/40	60/40
Plasticizers							
Benzoflex 988, g	-	7.0	21.0	35.0	35.0	-	-
Santicizer 141, g	-	-	-	-	-	14.0	35.0
Santicizer 148, g	-	-	-	-	-	-	-
Santicizer 160, g	-	-	-	-	-	-	-
Stan Flux LV	-	-	-	-	-	-	-
TCP	-	-	-	-	-	-	-
Fillers							
Graphite #2 Flake	-	-	-	-	3.5	-	-

Table 4B. Formulations of Polyurethane/Epoxy IPN Elastomers

Sample No.	18	19	20	21	22	23	24
Polyurethane							
Isonate 143L, g	3.89	3.89	3.89	3.89	3.89	3.89	3.89
Niax 31-28, g	37.35	37.35	37.35	37.35	37.35	37.35	37.35
Isonol 100, g	0.76	0.76	0.76	0.76	0.76	0.76	0.76
T-12, g	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Epoxy							
DER 330, g	28	28	28	28	28	28	28
BF_3-etherate, g	0.6	0.6	0.6	0.6	0.6	0.6	0.6
PU/Epoxy ratio	60/40	60/40	60/40	60/40	60/40	60/40	60/40
Plasticizers							
Benzoflex 988, g	-	-	-	-	-	-	-
Santicizer 141, g	-	-	-	-	-	-	-
Santicizer 148, g	14.0	35.0	-	-	-	-	-
Santicizer 160, g	-	-	14.0	35.0	-	-	-
Stan Flux LV	-	-	-	-	7.0	14.0	-
TCP	-	-	-	-	-	-	14.0
Fillers							
Graphite #2 Flake	-	-	-	-	-	-	-

Table 4C. Formulations of Polyurethane/Epoxy IPN Elastomers

Sample No.	25	26	27	28	29	30	31
Polyurethane							
Isonate 143L, g	3.89	3.89	4.80	3.24	3.24	2.59	2.59
Niax 31-28, g	37.35	37.19	35.70	31.12	31.12	24.90	24.90
Isonol 100, g	0.76	0.83	1.488	0.64	0.64	0.51	0.51
T-12, g	0.06	0.06	0.06	0.04	0.04	0.04	0.04
Epoxy							
DER 330, g	28	28	28	35.0	35.0	42.0	42.0
BF_3-etherate, g	0.6	0.6	0.6	0.6	0.6	0.6	0.6
PU/Epoxy ratio	60/40	60/40	60/40	50/50	50/50	40/60	40/60
Plasticizers							
Benzoflex 988, g	-	-	35.0	21.0	-	21.0	-
Santicizer 141, g	-	-	-	-	-	-	-
Santicizer 148, g	-	14.0	-	-	-	-	-
Santicizer 160, g	-	-	-	-	14.0	-	14.0
Stan Flux LV	-	-	-	-	-	-	-
TCP	35.0	-	-	-	-	-	-
Fillers							
Graphite #2 Flake	-	-	-	-	-	-	-

Table 5. Foam Formulations

	1	2	3	4	5	6	7	8	9
Isonate 143L	25	←	←	7.5	←	←	←	←	←
Niax 31-28	100	←	←	60	←	←	←	←	←
H_2O	1.05	←	←	0.77	←	←	←	←	←
1,4 Butanediol	-	-	-	-	-	-	-	-	-
A-1	0.06	←	←	0.06	←	←	←	←	←
T-12	0.02	←	←	0.02	←	←	←	←	←
DC-193	0.5	←	←	0.1	←	←	←	←	←
L-540	0.5	←	←	0.3	←	←	←	←	←
DER-330	-	-	-	8.6	←	←	←	←	←
XU-213	-	-	-	0.25	←	←	←	←	←
DMP-30	-	-	-	0.12		←	←	←	←
Freon-11A	15	←	←	20	←	←	←	←	←
Plasticizer	-	-	-	-	-	-	-	-	-
Filler*	0	12.5	25.0	0	4.3	8.7	13.0	17.3	21.7
PU/Epoxy	100/0	←	←	90/10	←	←	←	←	←
Filler, %	0	10	20	0	5	10	15	20	25
Plazticizer, %	-	-	-	-	-	-	-	-	-
1,4 Butanediol, %	-	-	-	-	-	-	-	-	-

*Graphite (#2 Flakes)

Table 5 (continued)

	10	11	12	13	14	15	16	17	18	19	20	21
Isonate 143L	20.3	←	←	←	←	←	17.4	←	←	←	←	←
Niax 31-28	60	←	←	←	←	←	50	←	←	←	←	←
H_2O	0.90	←	←	←	←	←	0.76	←	←	←	←	←
1,4 Butanediol	-	-	-	-	-	-	-	-	-	-	-	-
A-1	0.06	←	←	←	←	←	0.06	←	←	←	←	←
T-12	0.02	←	←	←	←	←	0.02	←	←	←	←	←
DC-193	0.1	←	←	←	←	←	0.10	←	←	←	←	←
L-540	0.3	←	←	←	←	←	0.30	←	←	←	←	←
DER-330	20.3	←	←	←	←	←	29.2	←	←	←	←	←
XU-213	0.30	←	←	←	←	←	0.44	←	←	←	←	←
DMP-30	0.15	←	←	←	←	←	0.22	←	←	←	←	←
Freon-11A	24	←	←	←	←	←	20	←	←	←	←	←
Plasticizer	-	-	-	-	-	-	-	-	-	-	-	-
Filler*	0	5	10	15	20	25	0	5	10	15	20	25
PU/Epoxy	80/20	←	←	←	←	←	70/30	←	←	←	←	←
Filler, %	0	5	10	15	20	25	0	5	10	15	20	25
Plazticizer, %	-	-	-	-	-	-	-	-	-	-	-	-
1,4 Butanediol, %	-	-	-	-	-	-	-	-	-	-	-	-

*Graphite (#2 Flakes)

Table 5 (continued)

	10	11	12	13	14	15	16	17	18	19	20	21
Isonate 143L	20.3	←	←	←	←	←	17.4	←	←	←	←	←
Niax 31-28	60	←	←	←	←	←	50	←	←	←	←	←
H_2O	0.90	←	←	←	←	←	0.76	←	←	←	←	←
1,4 Butanediol	-	-	-	-	-	-	-	-	-	-	-	-
A-1	0.06	←	←	←	←	←	0.06	←	←	←	←	←
T-12	0.02	←	←	←	←	←	0.02	←	←	←	←	←
DC-193	0.1	←	←	←	←	←	0.10	←	←	←	←	←
L-540	0.3	←	←	←	←	←	0.30	←	←	←	←	←
DER-330	20.3	←	←	←	←	←	29.2	←	←	←	←	←
XU-213	0.30	←	←	←	←	←	0.44	←	←	←	←	←
DMP-30	0.15	←	←	←	←	←	0.22	←	←	←	←	←
Freon-11A	24	←	←	←	←	←	20	←	←	←	←	←
Plasticizer	-	-	-	-	-	-	-	-	-	-	-	-
Filler*	0	5	10	15	20	25	0	5	10	15	20	25
PU/Epoxy	80/20	←	←	←	←	←	70/30	←	←	←	←	←
Filler, %	0	5	10	15	20	25	0	5	10	15	20	25
Plazticizer, %	-	-	-	-	-	-	-	-	-	-	-	-
1,4 Butanediol, %	-	-	-	-	-	-	-	-	-	-	-	-

*Graphite (#2 Flakes)

Table 5 (continued)

	22	23	24	25	26
Isonate 143L	21.4	←	←	27.8	←
Niax 31-28	50	←	←	50	←
H_2O	0.95	←	←	1.28	←
1,4 Butanediol	-	-	-	-	-
A-1	0.06	←	←	0.06	←
T-12	0.02	←	←	0.02	←
DC-193	0.5	←	←	0.5	←
L-540	0.5	←	←	0.5	←
DER-330	48.2	←	←	79.0	←
XU-213	0.72	←	←	1.20	←
DMP-30	0.36	←	←	0.80	←
Freon-11A	20	←	←	20	←
Plasticizer	-	-	-	-	
Filler*	0	12	24	0	16
PU/Epoxy	60/40	←	←	50/50	←
Filler, %	0	10	20	0	10
Plazticizer, %	-	-	-	-	-
1,4 Butanediol, %	-	-	-	-	-

*Graphite (#2 Flakes)

Table 5 (continued)

	27	28	29	30	31	32	33	34
Isonate 143L	25	17.5	20.3	17.4	21.4	17.5	←	←
Niax 31-28	100	60	60	50	50	60	←	←
H_2O	1.05	0.77	0.90	0.76	0.95	0.77	←	←
1,4 Butanediol	-	-	-	-	-	-	-	-
A-1	0.06	←	←	←	←	0.06	←	←
T-12	0.02	←	←	←	←	0.02	←	←
DC-193	0.5	0.1	←	←	0.5	0.1	←	←
L-540	0.5	0.3	←	←	0.5	0.3	←	←
DER-330	-	8.6	20.3	29.2	48.2	8.6	←	←
XU-213	-	0.25	0.30	0.44	0.72	0.25	←	←
DMP-30	-	0.12	0.15	0.22	0.36	0.12	←	←
Freon-11A	20	←	←	←	←	20	←	←
Plasticizer	-	-	-	-	-	17.4[1]	17.4[2]	17.4[3]
Filler*	12.5	8.7	10	10	12	-	-	-
PU/Epoxy	100/0	90/10	80/20	70/30	60/40	90/10	←	←
Filler, %	10	←	←	←	←	-	-	-
Plazticizer, %	-	-	-	-	-	20	←	←
1,4 Butanediol, %	-	-	-	-	-	-	-	-

[1] Santicizer 148

[2] Santicizer 160

[3] Stan Flux LV

Table 5 (continued)

	35	36	37	38	39	40	41
Isonate 143L	28.8	24	←	←	36.4	←	24
Niax 31-28	60	50	←	←	80	←	50
H_2O	0.81	0.90	←	←	1.44	←	0.90
1,4 Butanediol	2.7	1.12	←	←	1.80	←	1.12
A-1	0.06	←	←	←	0.06	←	0.06
T-12	0.02	←	←	←	0.02	←	0.02
DC-193	0.1	0.2	←	←	0.2	←	0.2
L-540	0.3	0.3	←	←	0.2	←	0.3
DER-330	40	32.5	←	←	-	-	32.5
XU-213	0.59	0.49	←	←	-	-	0.49
DMP-30	0.29	0.24	←	←	-	-	0.24
Freon-11A	30	26	←	←	20	←	22
Plasticizer	26[1]	22[1]	22[2]	22[3]	24[1]	0	32[1]
Filler*	-	-	-	-	-	-	-

PU/Epoxy	70/30	←	←	←	100/10	←	70/30
Filler, %	-	-	-	-	-	-	-
Plazticizer, %	20				20	0	30
1,4 Butanediol, %	2	1	←	←	1	1	1

[1] Benzoflex 988

[2] Santicizer 148

[3] Santicizer 160

Table 5 (continued)

	42	43	44	45	46	47	48	49	50
Isonate 143L	24	←	36	←	←	←	←	←	←
Niax 31-28	50	←	75	←	←	←	←	←	←
H_2O	0.90	←	1.35	←	←	←	←	←	←
1,4 Butanediol	1.12	←	1.68	←	←	←	←	←	←
A-1	0.06	←	0.09	←	←	←	←	←	←
T-12	0.02	←	0.03	←	←	←	←	←	←
L-5303	0.1	←	0.1	←	←	←	0.5	0.5	0.13
L-548	0.9	←	1.0	←	←	←	0.4	1.0	1.0
DER-330	32.5	←	48.8	←	←	←	←	←	←
XU-213	0.49	←	0.74	←	←	←	←	←	←
DMP-30	0.24	←	0.35	←	←	←	←	←	←
Freon-11A	20	←	10	20	30	40	30	←	←
Plasticizer	22[1]	22[2]	33[1]	←	←	←	←	←	←
Filler*	-	-	-	-	-	-	-	-	-
PU/Epoxy	70/30	←	←	←	←	←	←	←	←
Filler, %	-	-	-	-	-	-	-	-	-
Plazticizer, %	20	←	←	←	←	←	←	←	←
1,4 Butanediol, %	1	←	←	←	←	←	←	←	←
L-548/L-5303	9/1		10/1	10/1	10/1	10/1	1/1	2/1	8/1

[1]Santicizer 148

[2]Santicizer 160

Table 6. Pure Polyurethane System

Figure No.	1	2	3	4	5	6	7	8	9	10
Sample No.	1	2	3	4	5	6	7	8	9	10
Plasticizer used										
TCP, %	-	20	50	-	-	-	-	-	-	-
Santicizer 141, %	-	-	-	20	50	-	-	-	20	50
Santicizer 160, %	-	-	-	-	-	20	-	-	-	-
Benzoflex 988, 5	-	-	-	-	-	-	20	-	-	-
Stan Flux LV, %	-	-	-	-	-	-	-	20	-	-
Temp. range (°C)	-43 to +20 (63)	-44 to +52 (96)	-48 to +28 (76)	-46 to +12 (58)	-47 to +16 (63)	-50 to +40 (90)	-50 to +44 (94)	-46 to +40 (86)	-52 to +26 (78)	-48 tc +44 (92
Height of tan	0.96	1.5	1.75	1.4	1.7	1.6	1.48	1.26	1.0	1.
Temp. at peak (°C)	-24	-28	-30	-32	-40	-26	-28	-28	-12	-24
Area under the curve	35.16	47.35	55.61	38.62	43.18	49.56	50.44	48.35	43.54	53.

Systems 1 through 8 used 2% Isonal 100
Systems 9 and 10 used 8% Isonal 100

TABLE 7A

REFERENCE SYSTEM

60/40 Polyurethane/Epoxy + 2% Isonol 100 + No Plasticizer

S. No.	System	Tan δ Max.	Temp. at Tan δ Max. (Degree °C)	Temp. Range (Degree °C)	Area under the Curve
1	Ref.	0.65	40	-20°C to 108°C (i.e. 128°C)	43.90

N.B.: 1) Temp. range has been consider from the point of inflection.
2) Area under the curve is calculated by Simpson's rule method.

TABLE 7B

Effect of Benzoflex 9-88

S. No.	System	Tan δ Max.	Temp. at Tan δ (Degree °C)	Temp. Range (Degree °C)	Area Under the Curve
1	Ref.	0.65	40°	-20° to 108° (i.e. 128°)	43.90
2	Ref. + 10% Benzoflex 9-88	0.85	20° - 24°	-40° to 40° (i.e. 80°)	36.395
3	Ref. + 30% Benzoflex 9-88	0.86	12°	-24° to 24°* (i.e. 48°)	26.166
4	Ref. + 50% Benzoflex 9-88	1.7	0°	-36° to 12°* (i.e. 48°)	40.639
5.	Ref. + 50% Benzoflex 9-88 + 5% Graphite filler #2 Flake	1.2	5°	-40° to 32°* (i.e. 72°)	50.967

*Actual temp. range is more than the specified by +5°C to 20°C.

TABLE 7C

Effect of Stanticizer 141 & Santicizer 148

S. No.	System	Tan δ Max.	Temp. at Tan δ (Degree °C)	Temp. Range (Degree °C)	Area Under the Curve
1	Ref.	0.65	40°	-20° to 108° (i.e. 128°)	43.90
2	Ref. + 20% Santicizer 141	0.675	24°	-44° to 60°* (i.e. 104°)	33.540
3	Ref. + 50% Santicizer 141	0.70	28°	-48° to 48° (i.e. 96°)	34.290
4	Ref. + 20% Santicizer 148	0.60	28° - 32°	-40° to 64°* (i.e. 104°)	34.578
5	Ref. + 50% Santicizer 148	0.83	12°	-44 to 28° (i.e. 72°)	32.711

*Actual temp. range is more than the specified by +5° to 20°C.

TABLE 7D

Effect of Santicizer 160 & Stan-Flux-LV

S. No.	System	Tan δ Max.	Temp. at Tan δ (Degree °C)	Temp. Range (Degree °C)	Area Under the Curve
1	Ref.	0.65	40°	-20° to 108° (i.e. 128°)	43.90
2	Ref. + 20% Santicizer 160	0.73	24°	-36° to 60° (i.e. 96°)	32.695
3	Ref. + 50% Santicizer 160	1.65	-7°	-40° to 4°**	
4	REf. + 10% Stan Flux-LV	1.2	8°	-36° to 34°**	
5	Ref. + 20% Stan Flux-LV	0.93	16°	-40° to 64* (i.e. 104°)	50.73

*Actual temp. range is more than the specified by +5° to +20°C.

**Actual temp. range is more than the specified by +20° to +40°C.

TABLE 7E

Effect of TCP (Tri Cresyl Phosphate)

S. No.	System	Tan Max.	Temp. at Tan (Degree °C)	Temp. Range (Degree °C)	Area Under the Curve
1	Ref.	0.65	40°	-20° to 108° (i.e. 128°)	43.90
2	Ref. + 20% TCP	0.60	20° - 24°	-36° to 52° (i.e. 88°)	26.521
3	Ref. + 50% TCP	0.60	-4°	-40° to 32°* (i.e. 72°)	21.278

*Actual temp. range is more than the specified by +5° to +20°C.

TABLE 7F

Effect of Polyurethane/Epoxy Ratio

S. No.	PU/E Ratio	System	Tan Max.	Temp. at Tan (Degree °C)	Temp. Range (Degree °C)	Area Under the Curve
1	60/40	Ref. + 30% Benzoflex 9-88	0.86	12°	-24° to 24°* (i.e. 48°)	26.166
2	50/50	Ref. + 30% Benzoflex 9-88	0.80	24° - 28°	-12° to 60° (i.e. 72°)	34.253
3	40/60	Ref. + 30% Benzoflex 9-88	1.2	20°	-39° to 56° (i.e. 96°)	42.71
4	60/40	Ref. + 20% Santi. 160	0.73	24°	-36° to 60° (i.e. 96°)	32.695
5	50/50	Ref. + 20% Santi. 160	0.90	12°	-28° to 44° (i.e. 72°)	31.1
6	40/60	Ref. + 20% Santi. 160	1.34	20°	-12° to 71° (i.e. 83°)	48.03
7	100% PU		0.96	-24°	-43° to 20° (i.e. 63)	35.16
8	100% PU	System 7 + 20% Santi. 160	1.6	-26°	-50° to 40° (i.e. 90)	49.56

* Actual temp. range is more than the specified by +5° to +20°C.

TABLE 7G

UNCURED SAMPLES

NO.	SYSTEM	MAX. TAN	TEMP. AT TAN (DEGREE °C)	TEMP. RANGE (DEGREE °)	AREA UNDER THE CURVE
1.	60/40 PU/E + 2% Isonol-100 + 10% Benzoflex 9-88	1.1	12°C	-24°C to 72°C (i.e. 96°C)	55.166
2.	60/40 PU/E + 2% Isonol-100 + 30% Benzoflex 9-88	1.15	8°C	-32°C to64°C (i.e. 96°C)	49.253
3.	60/40 PU/E + 2% Isonol-100 + 50% Benzoflex 9-88	1.75Δ	Δ	-32°C to 20°C ** (i.e. 54°C)	
4.	60/40 PU/E + 2% Iosnol-100 + 50% Benzoflex + 5% Graphite	1.60	8-4	-36°C to 22°C** (i.e. 58°C)	
5.	60/40 PU/E + 2% Isonol-100 + 20% Santicizer-141	0.90	4	-44°C to 64°C (i.e. 108°C)	41.646
6.	60/40 PU/E + 2% Isonol-100 + 50% Santicizer-141	0.80	16-20	-48°C to 80°C (i.e. 128°C)	49.90
7.	60/40 PU/E + 2% Isonol-100 + 20% Santicizer-160	0.875	12	-44 to 40°C * (i.e. 84°C)	31.50
8.	60/40 PU/E + 2% Isonol-100 + 50% Santicizer-160	1.60Δ	Δ	-48 to 4°C ** (i.e. 52°C)	
9.	60/40 PU/E + 2% Isonol-100 + 20% TCP	0.925	16	-40 to 40°C (i.e. 80°C)	38.036
10.	60/40 PU/E + 2% Isonol-100 + 50% TCP	0.40	-4	-44 to 16°C** (i.e. 60°C)	

Δ Beyond the Instrument Range.
*Actual temp. Range is more than the specified by +5° to +20°C
** Actual temp. Range is more than the specified by +20 to +40°C

Table 8
% Wt. Loss After THF Extraction

S. No.	System	Wt. Loss in %
1	Uncured	14.10
2	2 hrs. post cured	13.40
3	4 hrs. post cured	12.10
4	8 hrs. post cured	11.33
5	16 hrs. post cured	8.80

Table 9

S. No.	System	TMA
1	Pure polyurethane	-43°C to -26°C
2	Pure polyurethane + 20% TCP	-41°C to -23.5°C
3	Pure polyurethane + 50% TCP	-44°C to -28°C
4	Pure polyurethane + 20% Santicizer 141	-48°C to -26°C
5	Pure polyurethane + 50% Santicizer 141	-63°C to -51°C
6	Pure polyurethane + 20% Santicizer 160	-55.5°C to -43°C
7	Pure polyurethane + 20% Benzoflex 988	-43°C to -25.5°C
8	Pure polyurethane + 20% StanFlux LV	-58.5°C to -46°C
9	Pure polyurethane + 20% Santicizer 141	-41°C to -12°C
10	Pure polyurethane + 50% Santicizer 141	-48°C to -28°C

Systems 1 through 8 used 2% Isonol 100.

Systems 9 and 10 used 8% Isonol 100.

Table 10

S. No.	System	First Peak	Second Peak
11	60/40 + no plasticizer	-10.0°C	+173.0°C
12	" + 10% Benzoflex 988	-13.0°C	+174.0°C
13	" + 30% Benzoflex 988	-21.0°C	+202.0°C
14	" + 50% Benzoflex 988	-21.0°C	+173.0°C
15	" + 50% Benzoflex + 5% filler	-15.5°C	+201.0°C
16	" + 20% Santicizer 141	-6.0°C	+207.0°C
17	" + 50% Santicizer 141	-5.0°C	+231.5°C
18	" + 20% Santicizer 148	-6.5°C	+172.0°C
19	" + 50% Santicizer 148	-33.0°C	+211.0°C
20	" + 20% Santicizer 160	-11.0°C	+204.0°C
21	" + %0 % Santicizer 160	-31.0°C	+178.0°C
22	" + 10% Stan Flux LV	-12.5°C	+168°C
23	" + 20% Stan Flux	-13.0°C	+181.0°C
24	" + 20% TCP	-5.0°C	+211.0°C
25	" + 50% TCP	-21.0°C	+209.0°C
26	Approx. 60/40 + 20% Santi. 148	-37.0°C	+179.0°C
27	60/40 + 50% Benzoflex 988	-23.5°C	+192.0°C
28	50/50 + 30% Benzoflex	+4.0°C	-
29	50/50 + 20% Santi. 160	-19.0°C	+207.5°C
30	40/60 + 30 % Benzoflex 988	-14.0°C	-
31	40/60 + 20% Santi. 160	-2.5°C	+207.5°C

Systems 11 through 31 used 2% Isonol-100 except systems 26 and 27.

TABLE 11

Statistical Analysis on Areas Under Sound Absorption Curves.

UNIT = 1 RELATIVE DEVIATION

Sample No.	0-500 Hz	500-8000 Hz	0-8000 Hz
1	3.51	2.00	2,04
2	3.36	3.57	3,68
3	3.36	3.32	3,41
4	3.24	1.23	1,67
5	3.81	2.64	2,73
6	3.14	3.34	3,42
7	2.96	3.09	3,16
8	1.58	3.57	3,61
9	1.75	3.56	3,60
10	3.28	2.80	2,87
11	2.60	3.20	3,25
12	3.13	3.21	3,29
13	3.21	3.49	3,58
14	3.34	3.16	3,24
15	4.78	2.02	2,11
16	3.93	1.32	1,34
17	3.29	1.18	1,18
18	4.15	2.38	2,47
19	3.65	1.00	1,00
20	4.95	1.38	1,45
21	4.53	1.41	1,46
22	4.22	2.67	1,77

TABLE 11 (CONTINUED)

UNIT = 1 RELATIVE DEVIATION

Sample No.	0-500 Hz	500-8000 Hz	0-8000 Hz
23	4.21	2.77	2.88
24	2.44	4.24	4.34
25	3.90	3.28	3.40
26	1.81	3.36	3.39
27	1.00	4.17	4.20
28	1.88	3.86	3.92
29	3.07	3.20	3.28
30	4.44	1.71	1.77
31	3.83	1.91	1.96
32	2.47	4.16	4.26
33	2.38	4.67	4.79
34	4.12	2.29	2.37
35	1.95	3.69	3.74
36	2.63	3.45	3.53
37	1.03	4.69	4.76
38	4.01	3.88	4.02
39	3.02	2.86	2.92
40	3.13	3.36	3.45
41	1.62	4.26	4.33

Table 12 . Property Measurements of Foam Samples

No.	Hyster-esis (%)	Density (pcf)	Rebound (%)	Tensile Strength (KPa)	Elongation (T)	50% Com-pression (KPa)
1	28	3.4	35	158	120	15
2	30	3.9	33	152	115	15
3	31	4.3	32	138	107	16
4	39	2.4	20	140	100	21
5	27	2.3	12	108	75	26
6	40	2.3	12	90	75	21
7	42	2.5	16	105	100	18
8	43	2.6	14	96	100	24
9	52	2.6	17	69	65	18
10	43	2.5	14	113	120	13
11	31	2.2	7	86	124	22
12	33	2.6	7	102	105	17
13	40	2.7	11	99	113	19
14	42	2.7	11	83	105	17
15	40	3.9	11	72	85	11
16	47	2.6	8	114	130	13
17	53	2.7	6	94	115	18
18	51	2.7	4	84	115	10
19	54	2.6	4	69	124	16
20	54	3.2	6	78	105	12
21	53	3.1	8	75	100	18
22	73	3.1	8	89	150	15
23	58	3.2	6	69	124	14
24	69	4.0	6	58	95	12
25	83	2.8	3	66	90	18
26	85	3.2	13	83	62	11
27	35	4.3	39	207	124	15
28	48	3.1	24	153	100	21
29	51	3.7	17	144	112	15
30	39	3.4	9	108	111	9

Table 12 (continued)

No.	Hyster-esis (%)	Density (pcf)	Rebound (%)	Tensile Strength (KPa)	Elongation (%)	50 % Com-pression (KPa)
31	53	5.0	12	158	90	10
32	31	3.6	16	63	107	15
33	27	3.2	18	50	90	10
34	36	4.3	19	138	107	13
35	40	3.5	1	108	129	12
36	45	3.9	7	108	120	11
37	30	2.9	3	37	116	17
38	37	3.7	6	75	116	10
39	39	2.8	16	72	98	18
40	54	2.0	15	56	76	25
41	50	3.9	3	63	116	12
42	42	3.4	4	64	186	7
43	38	3.6	6	55	189	8
44	40	3.7	11	83	192	10
45	42	3.2	5	69	161	7
46	46	2.8	2	69	198	6
47	51	2.6	1	69	191	5
48	42	2.5	1	60	122	4
49	45	2.9	2	60	122	6
50	46	2.7	1	72	165	5

Results on constant deflection compression set test:

The presence of the epoxy caused over 60% deflection of the original thickness of the sample. However, the thicknesses of the samples without epoxy were not affected in this test. The samples were deflected to 75% of the original thickness and were treated according to ASTM D-3574.

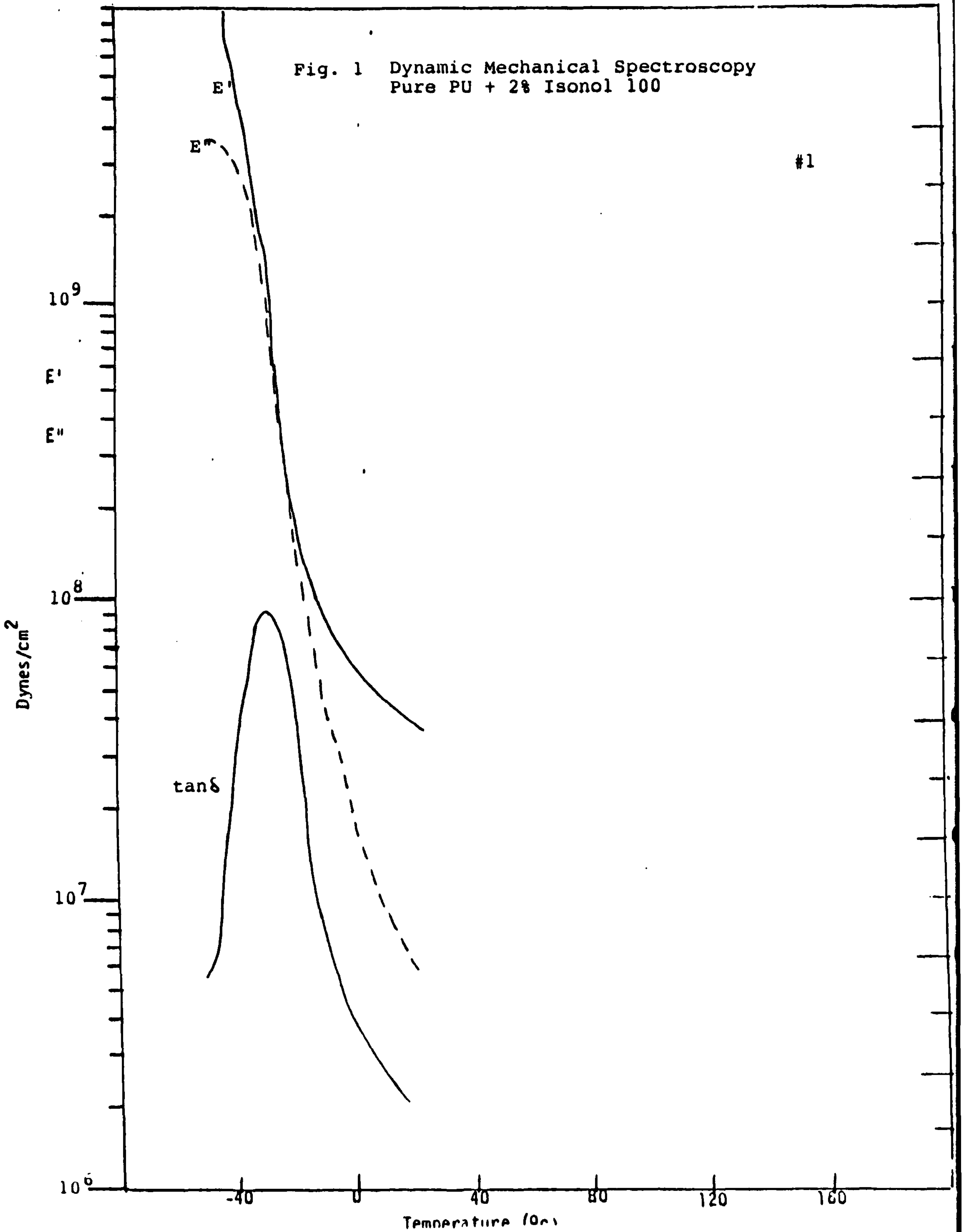
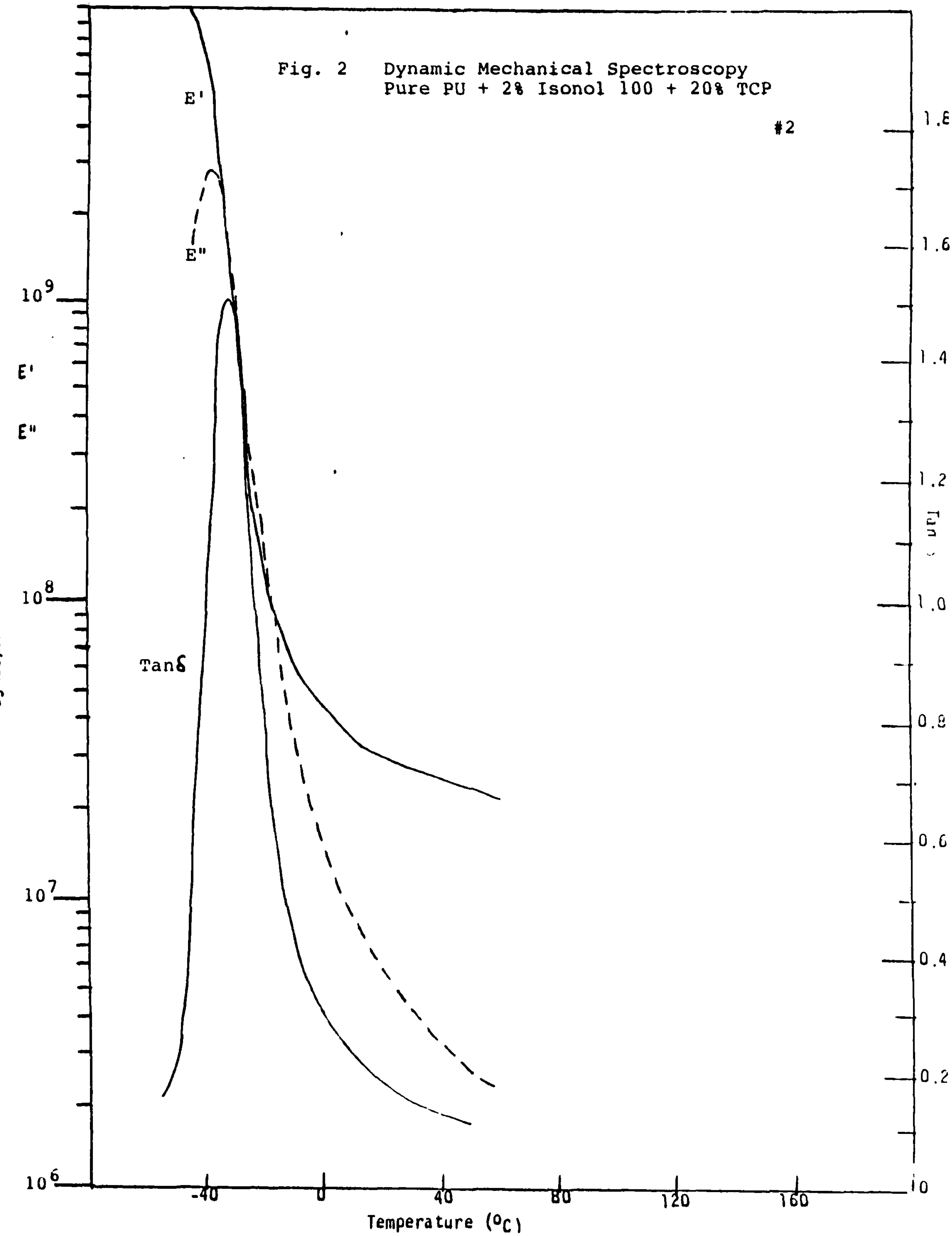


Fig. 1 Dynamic Mechanical Spectroscopy
Pure PU + 2% Isonol 100
#1
E'
E"
tanδ
Dynes/cm^2
E'
E"
10^9
10^8
10^7
10^6
-40
0
40
80
120
160
Temperature (°C)

Fig. 2 Dynamic Mechanical Spectroscopy
Pure PU + 2% Isonol 100 + 20% TCP



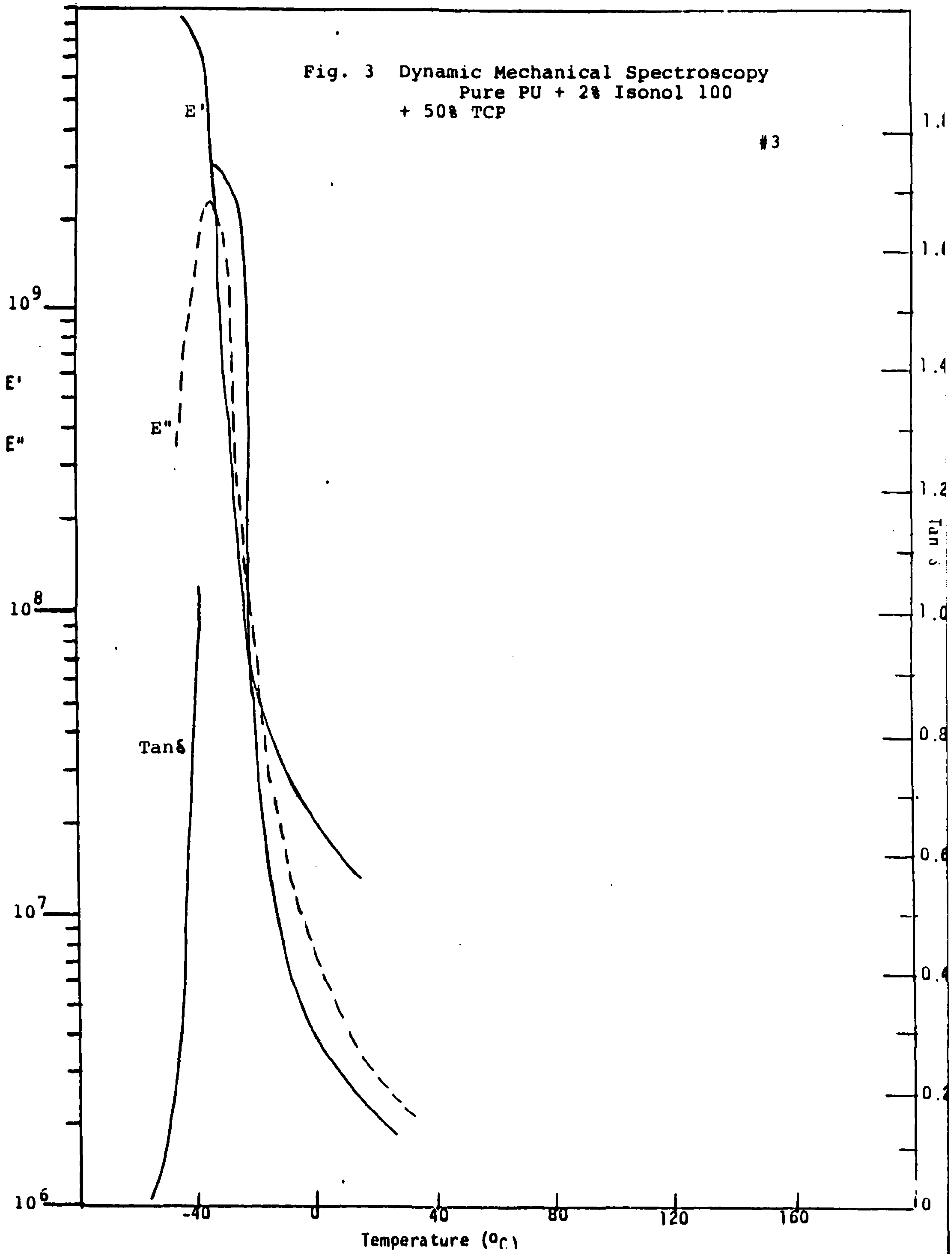


Fig. 3 Dynamic Mechanical Spectroscopy
Pure PU + 2% Isonol 100
+ 50% TCP
#3
E'
E"
Tanδ
10^9
10^8
10^7
10^6
E'
E"
Dynes/cm^2
-40
0
40
80
120
160
Temperature (°C)
1.0
0.8
0.6
0.4
0.2
0
Tan δ

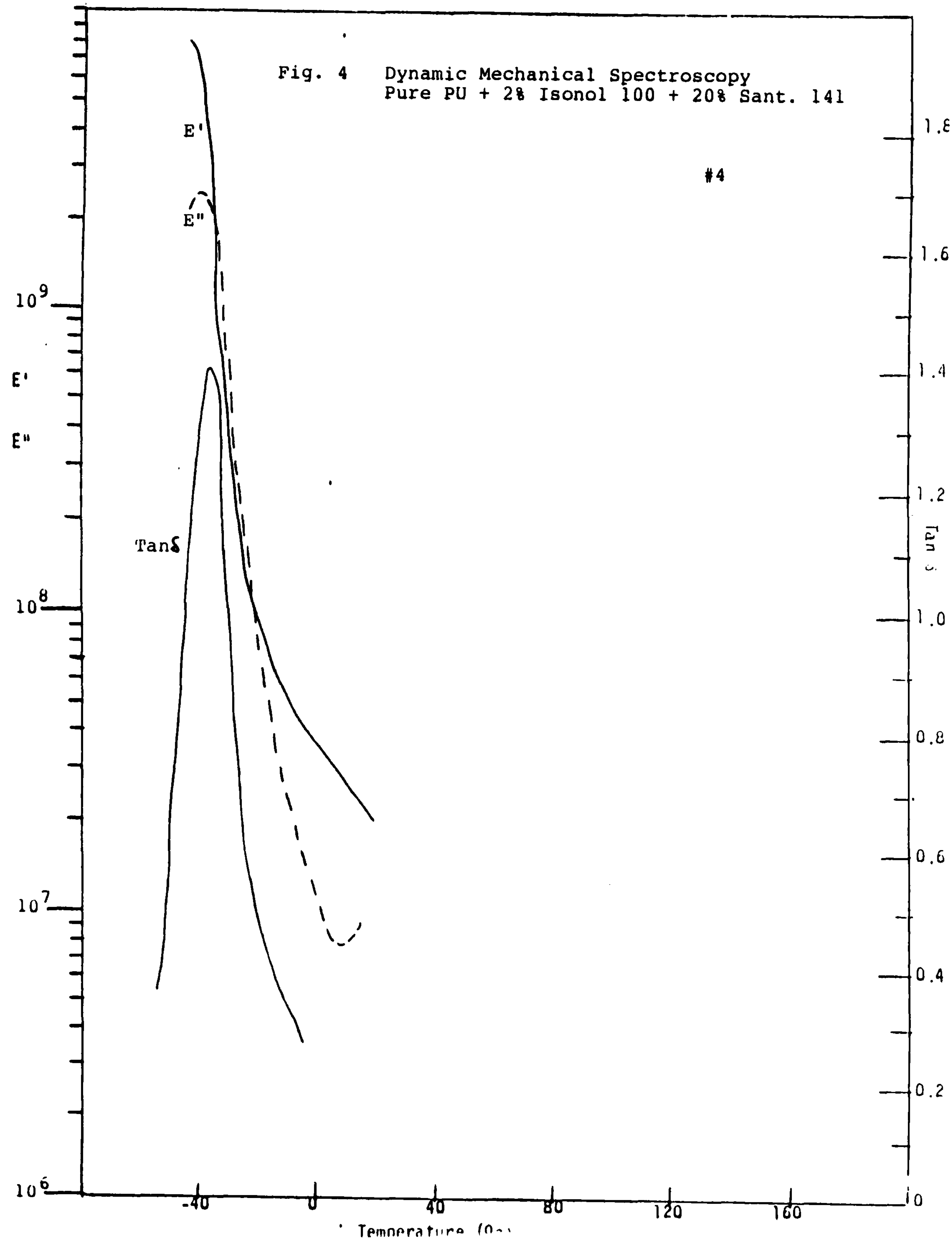


Fig. 4 Dynamic Mechanical Spectroscopy
Pure PU + 2% Isonol 100 + 20% Sant. 141
#4
E'
E"
Tan δ
10^9
10^8
10^7
10^6
E'
E"
Dynes/cm^2
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Tan δ
-40
0
40
80
120
160

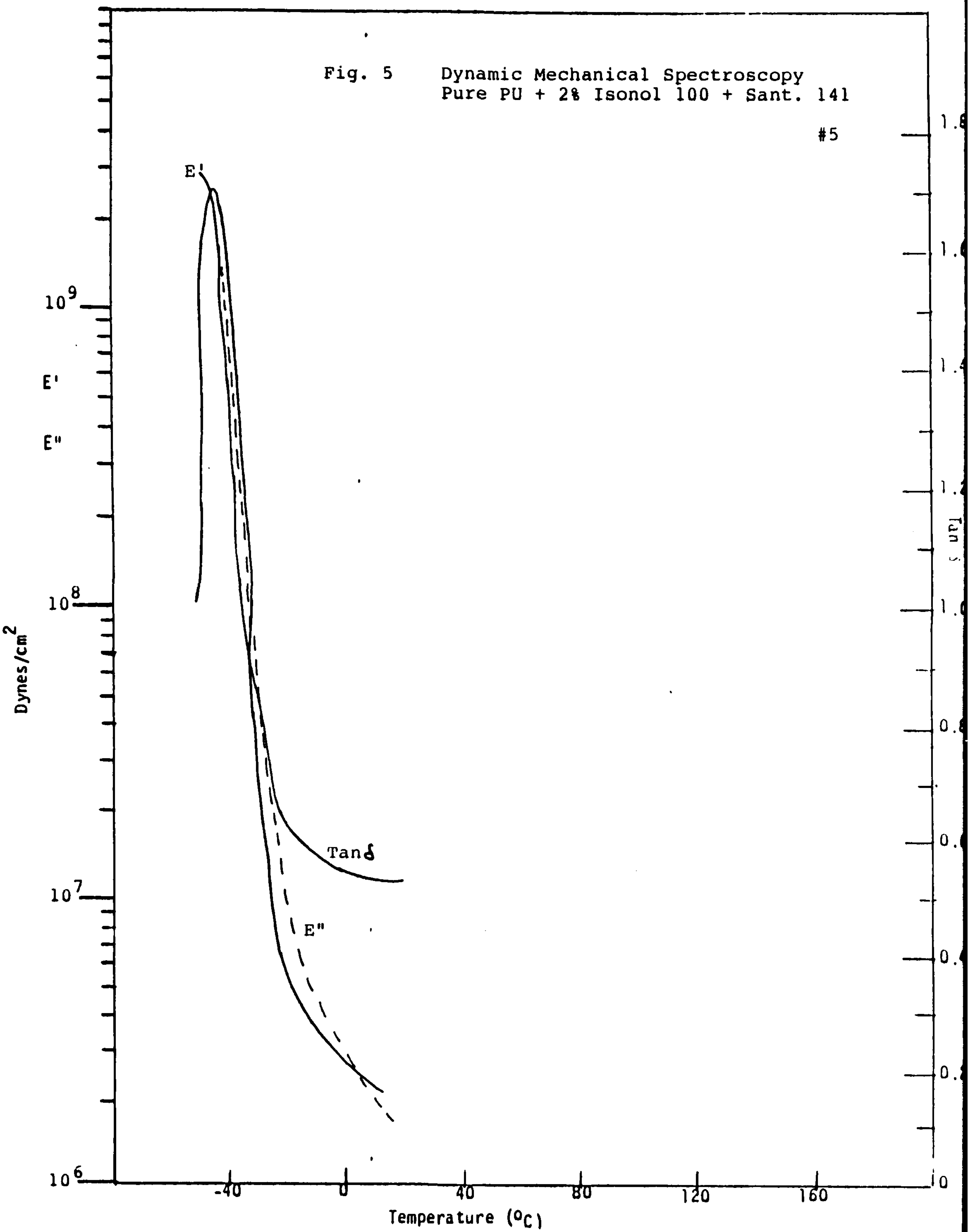


Fig. 5 Dynamic Mechanical Spectroscopy
Pure PU + 2% Isonol 100 + Sant. 141
#5
E'
Tanδ
E"
10^9
10^8
10^7
10^6
E'
E"
Dynes/cm^2
-40
0
40
80
120
160
Temperature (^oC)
0
Tan δ

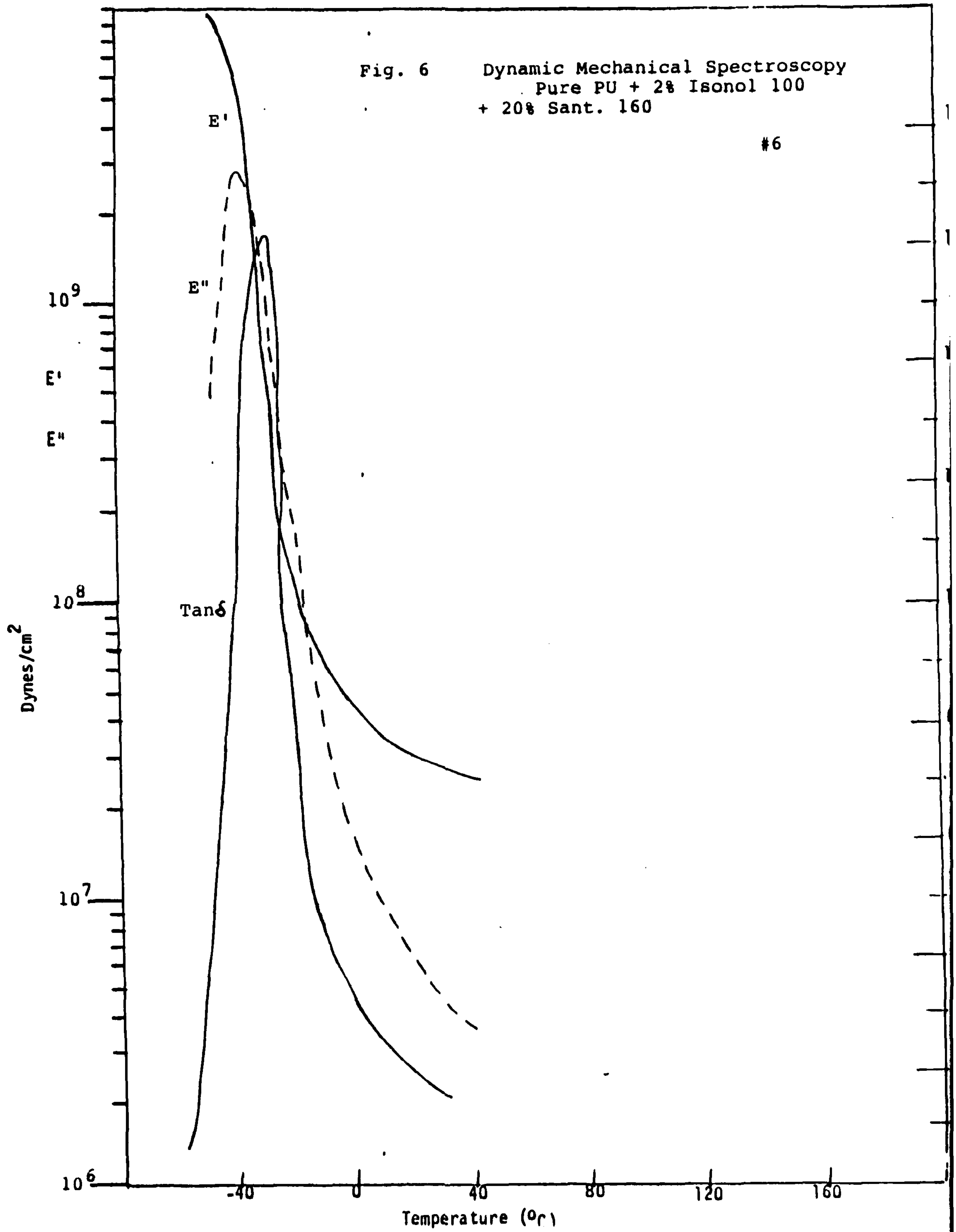


Fig. 6 Dynamic Mechanical Spectroscopy
Pure PU + 2% Isonol 100
+ 20% Sant. 160
#6
E'
E"
Tanδ
E'
E"
Dynes/cm^2
10^9
10^8
10^7
10^6
-40
0
40
80
120
160
Temperature (°C)

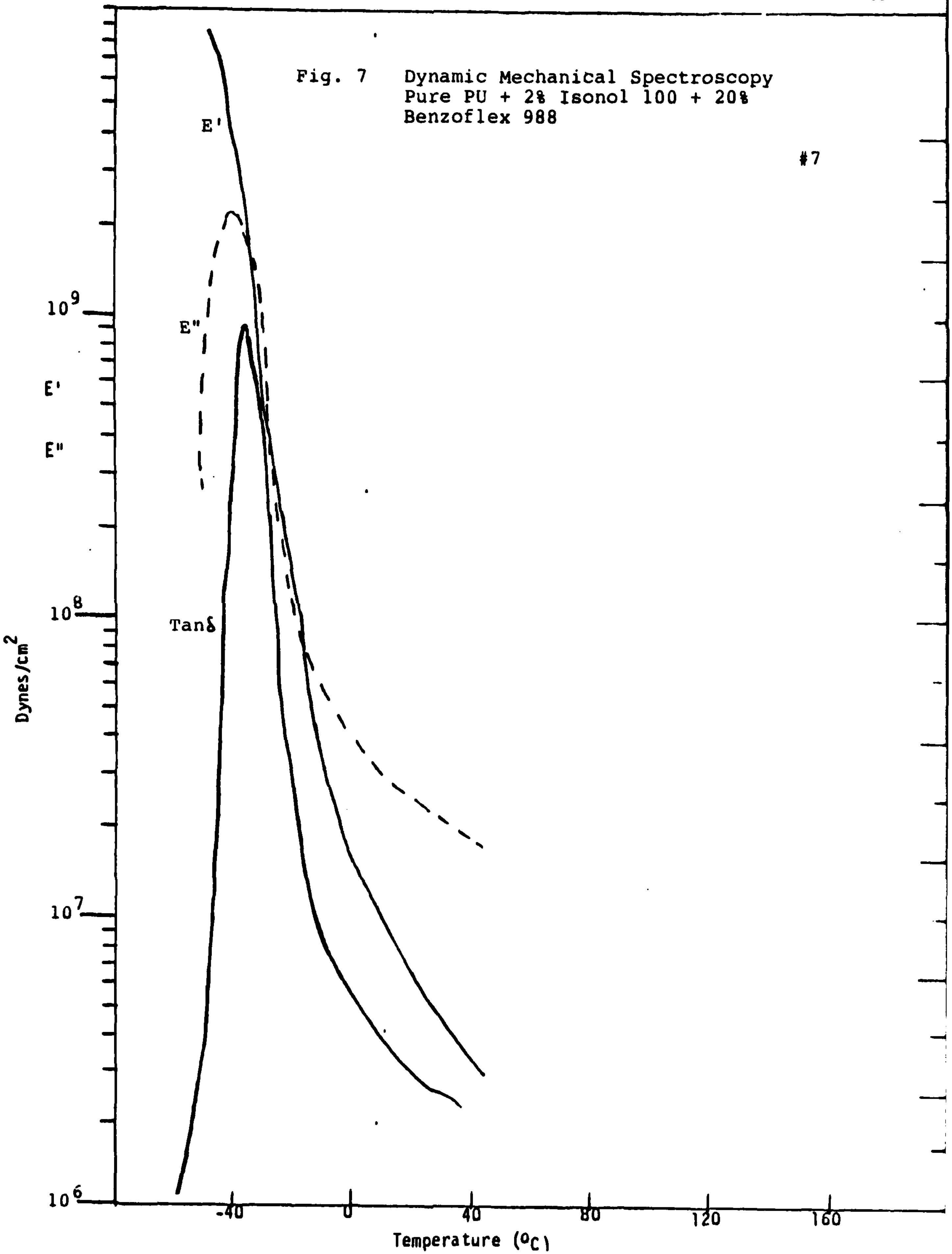


Fig. 7 Dynamic Mechanical Spectroscopy
Pure PU + 2% Isonol 100 + 20%
Benzoflex 988
#7
E'
E"
Tanδ
E'
E"
Dynes/cm2
10^9
10^8
10^7
10^6
-40
0
40
80
120
160
Temperature (°C)

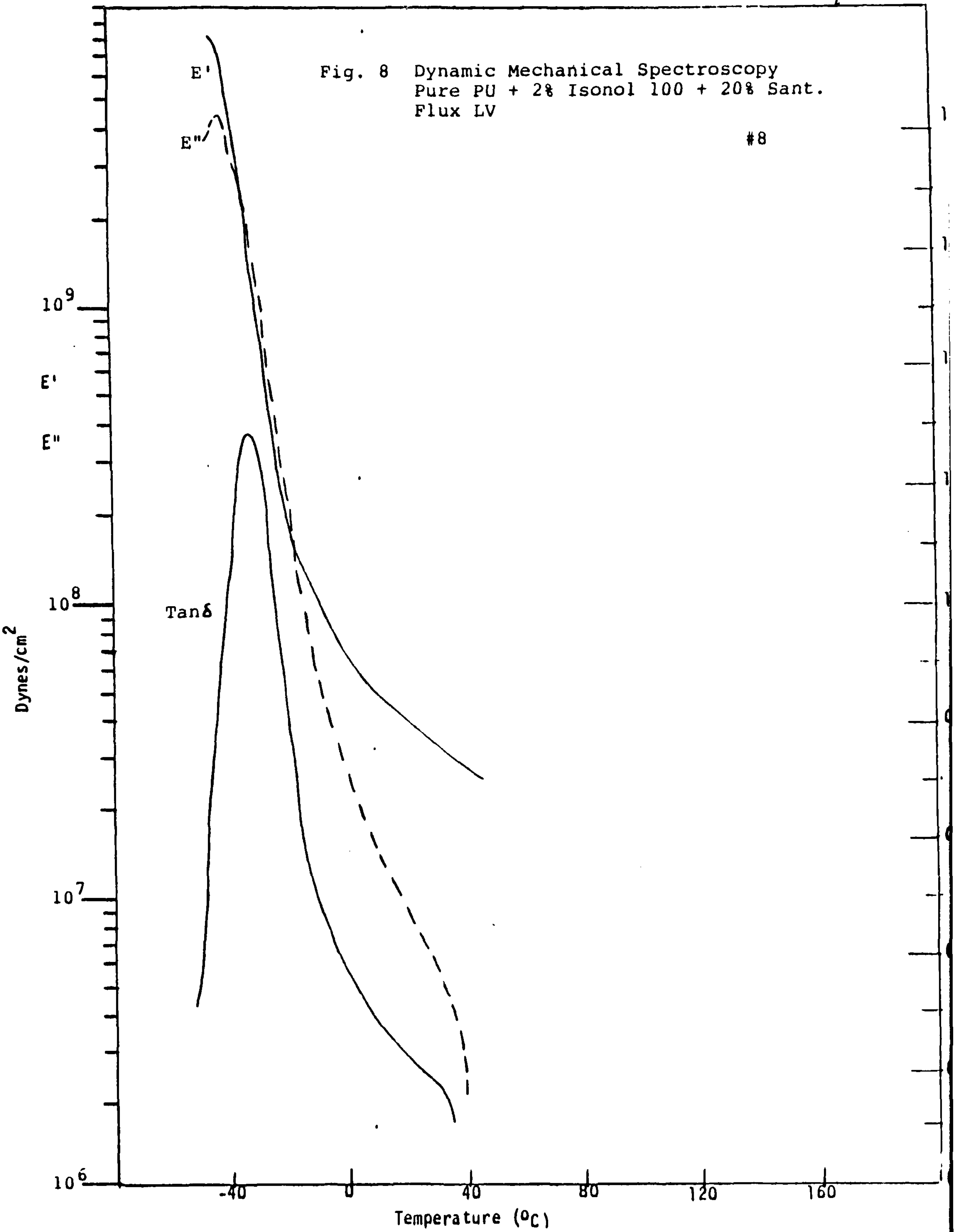


Fig. 8 Dynamic Mechanical Spectroscopy
Pure PU + 2% Isonol 100 + 20% Sant.
Flux LV
#8
E'
E"
Tan δ
10^9
10^8
10^7
10^6
E'
E"
Dynes/cm^2
-40
0
40
80
120
160
Temperature (^oC)

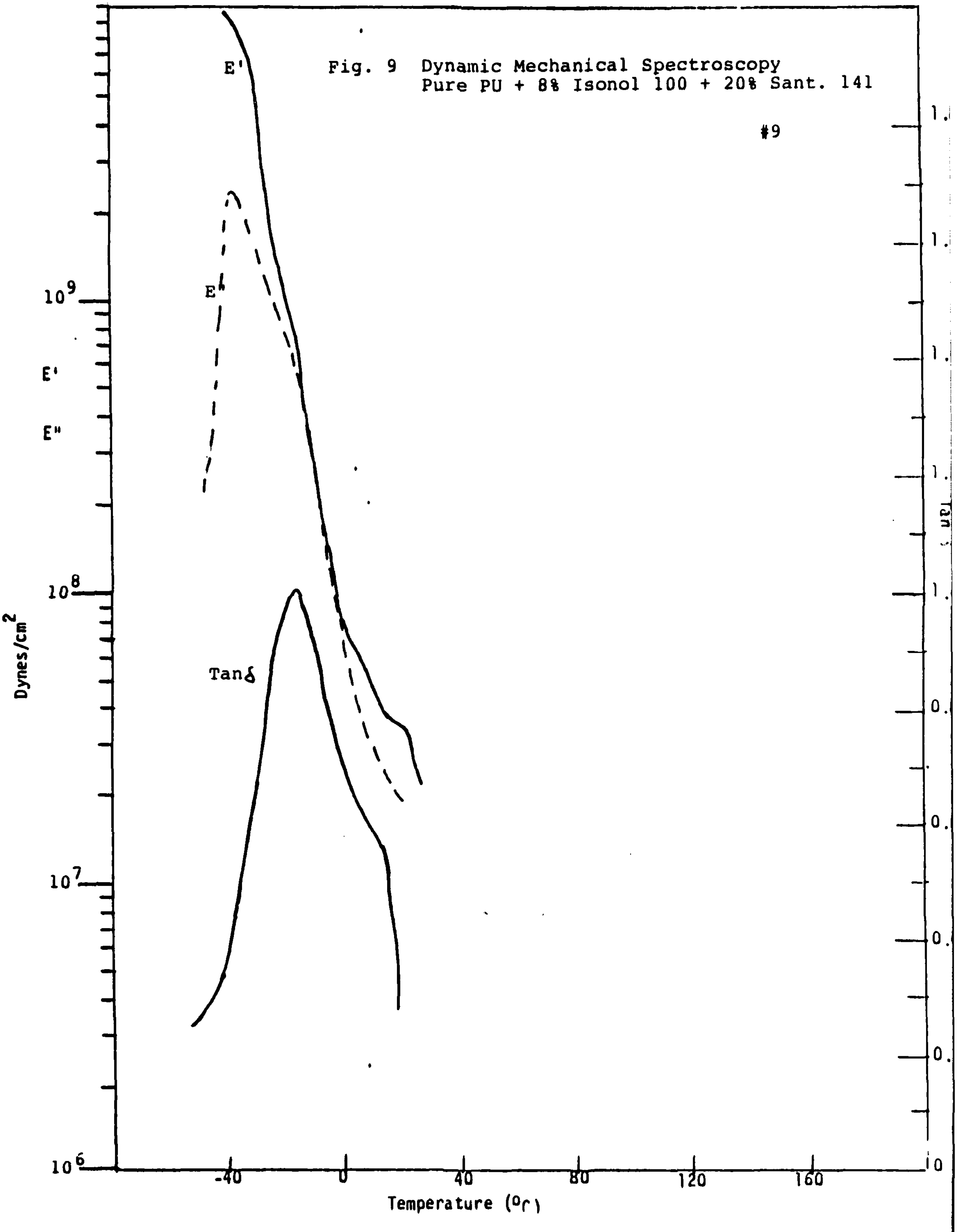


Fig. 9 Dynamic Mechanical Spectroscopy
Pure PU + 8% Isonol 100 + 20% Sant. 141
#9
E'
E"
Tan δ
E'
E"
Dynes/cm²
10⁹
10⁸
10⁷
10⁶
-40
0
40
80
120
160
Temperature (°C)

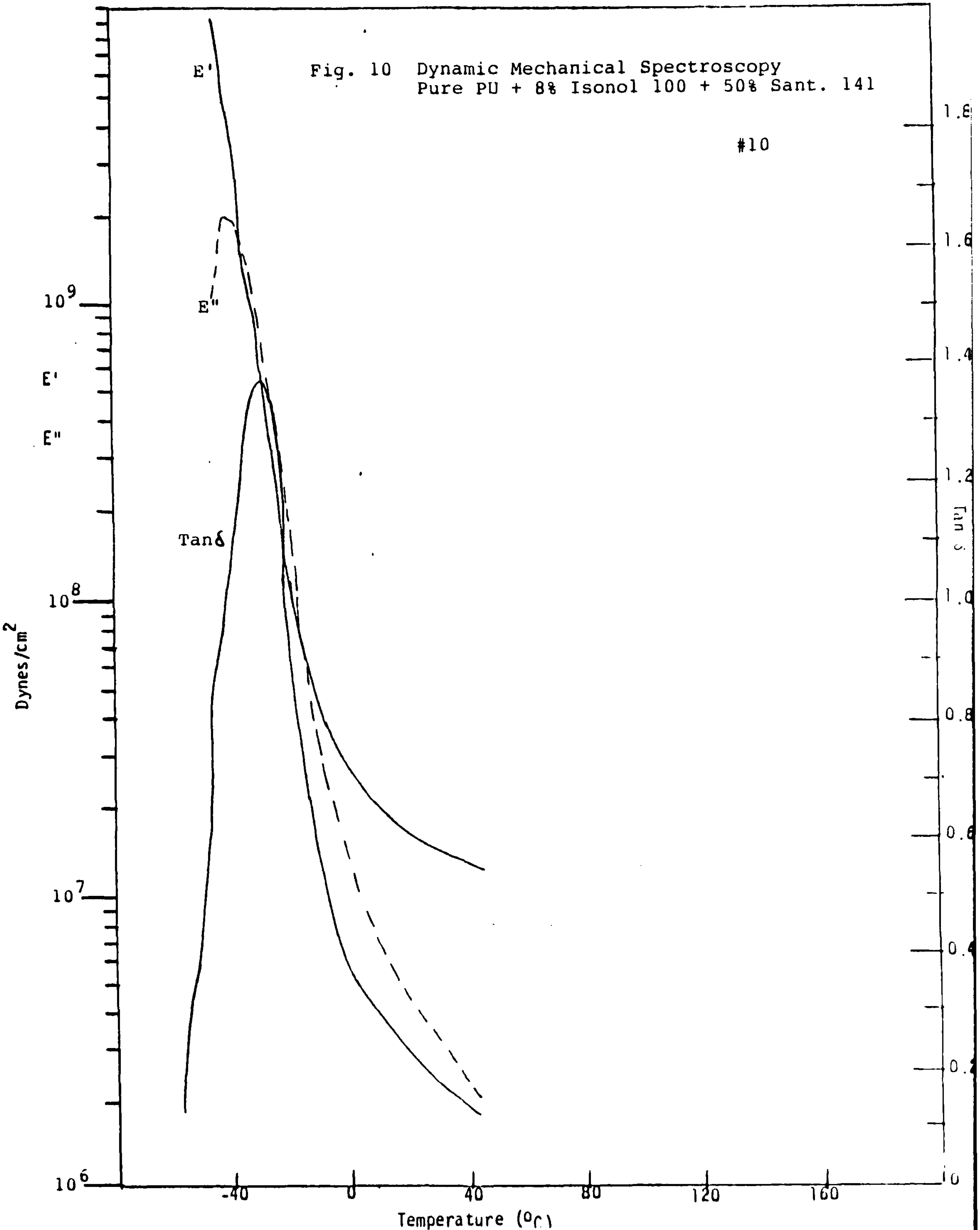
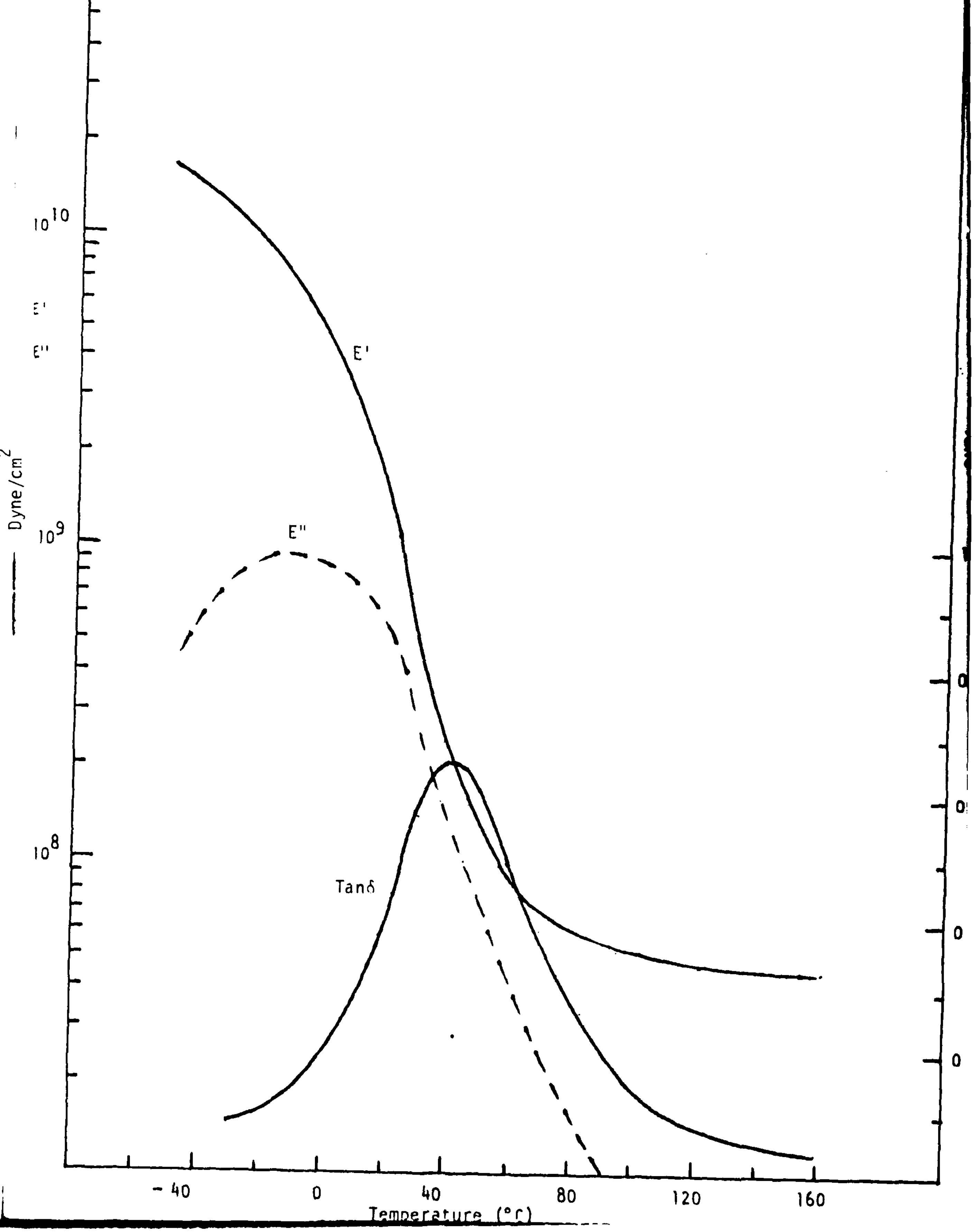


Fig. 10 Dynamic Mechanical Spectroscopy
Pure PU + 8% Isonol 100 + 50% Sant. 141
#10
E'
E"
Tanδ
10^9
10^8
10^7
10^6
E'
E"
Dynes/cm^2
-40
0
40
80
120
160
Temperature (°C)

Figure 11 Dynamic mechanical spectroscopy of PU/Epoxy (60/40) IPN



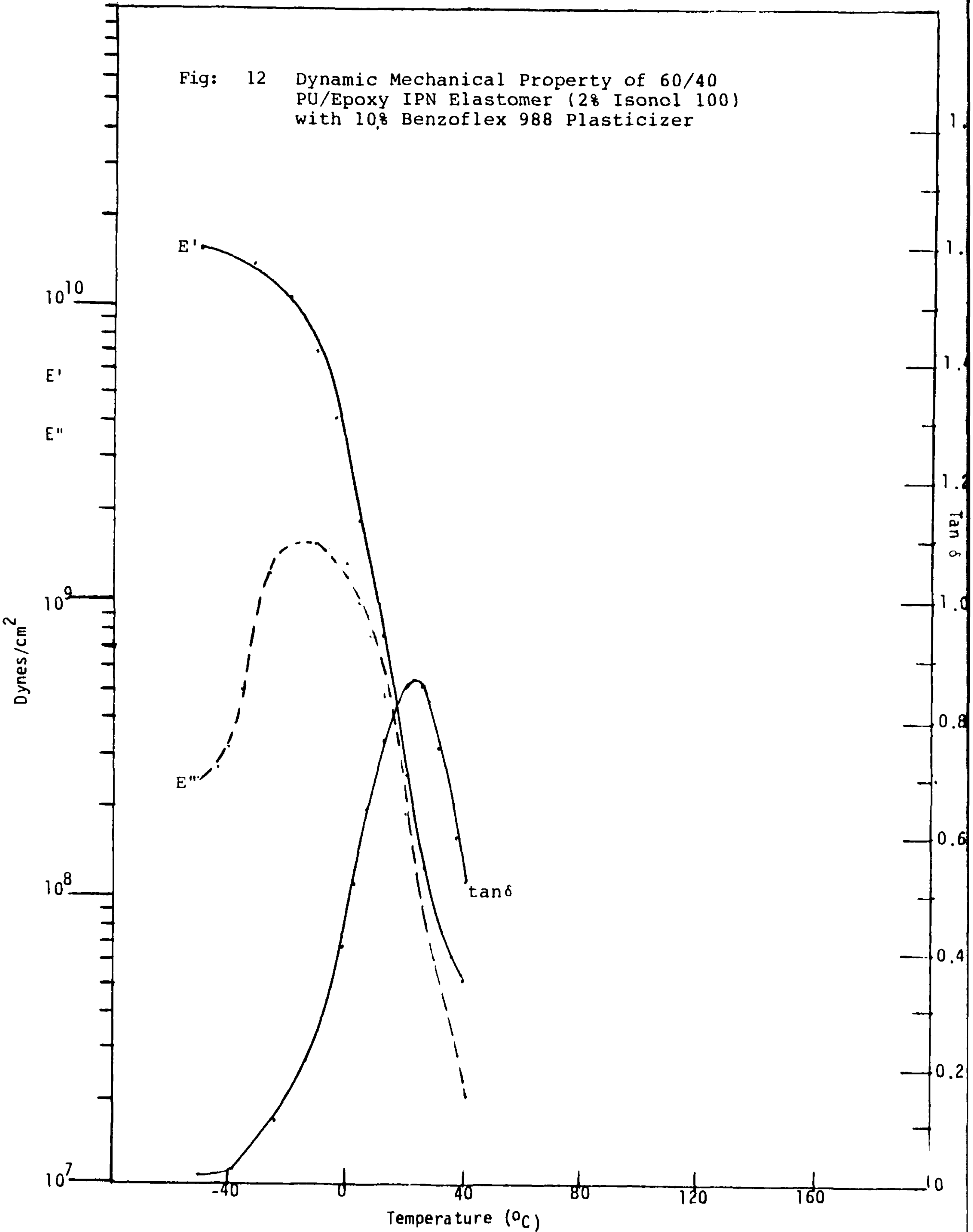


Fig: 12 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 10% Benzoflex 988 Plasticizer

Fig: 13 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 30% Benzoflex 988 Plasticizer

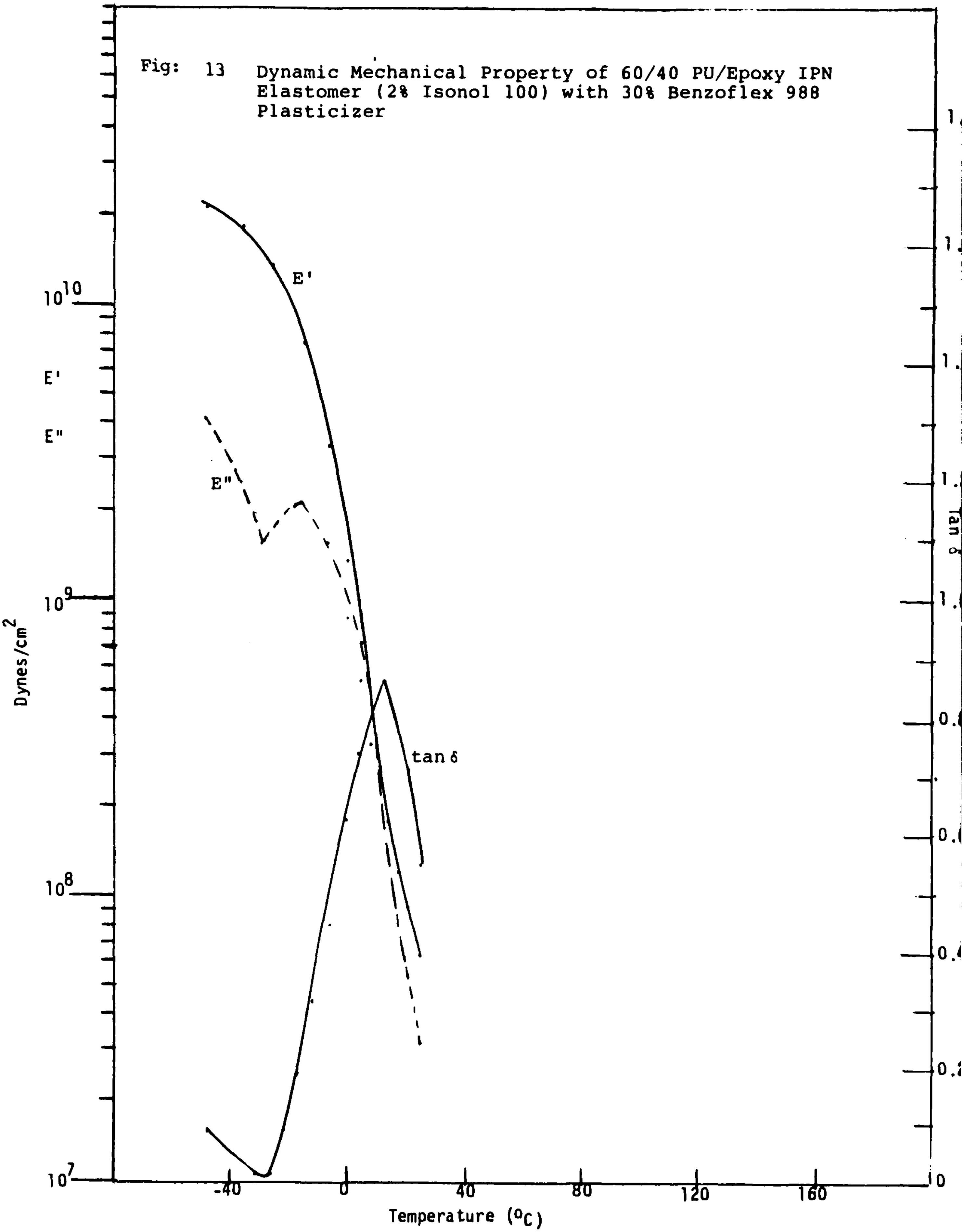


Fig: 14 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 50% Benzoflex 988 Plasticizer

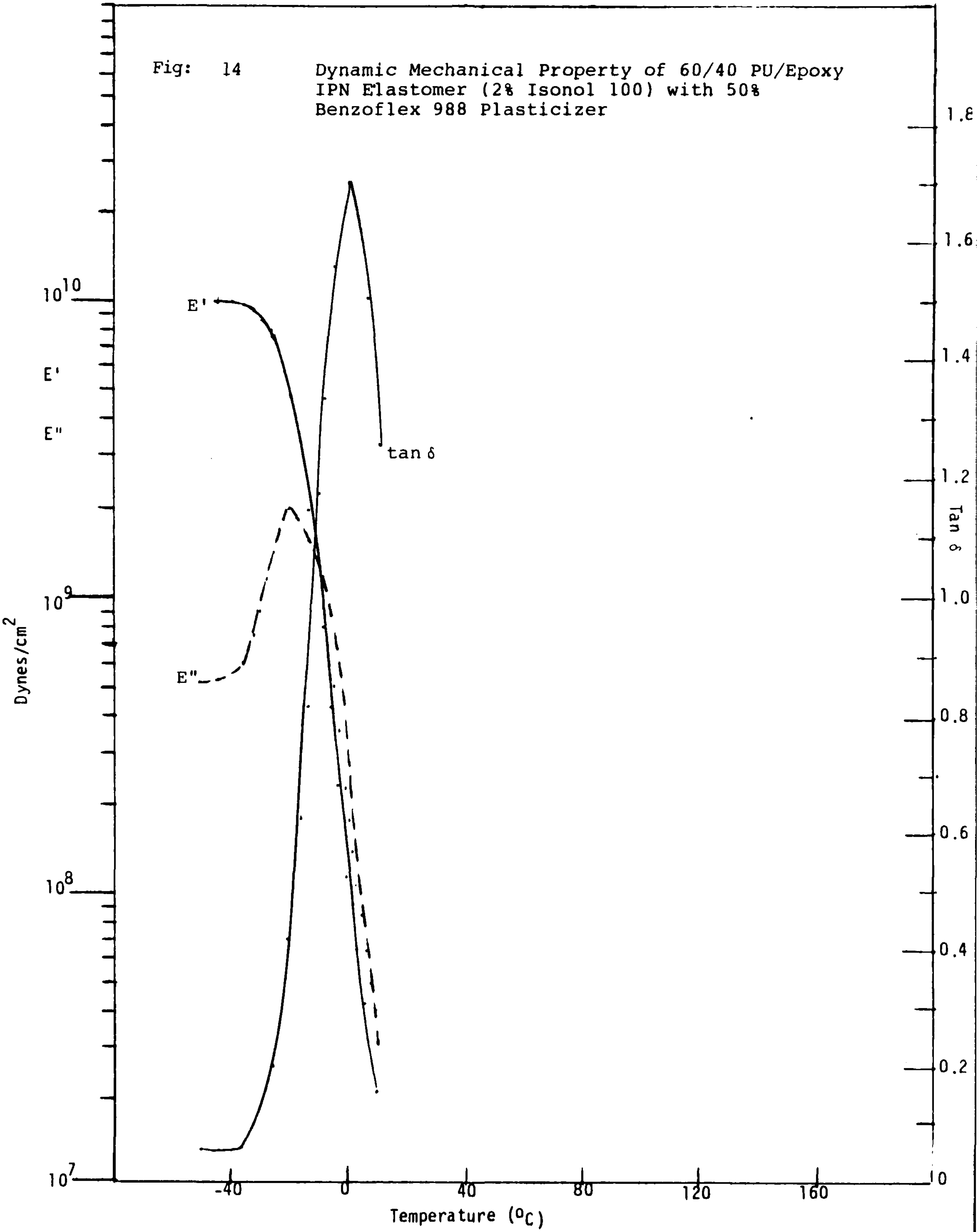
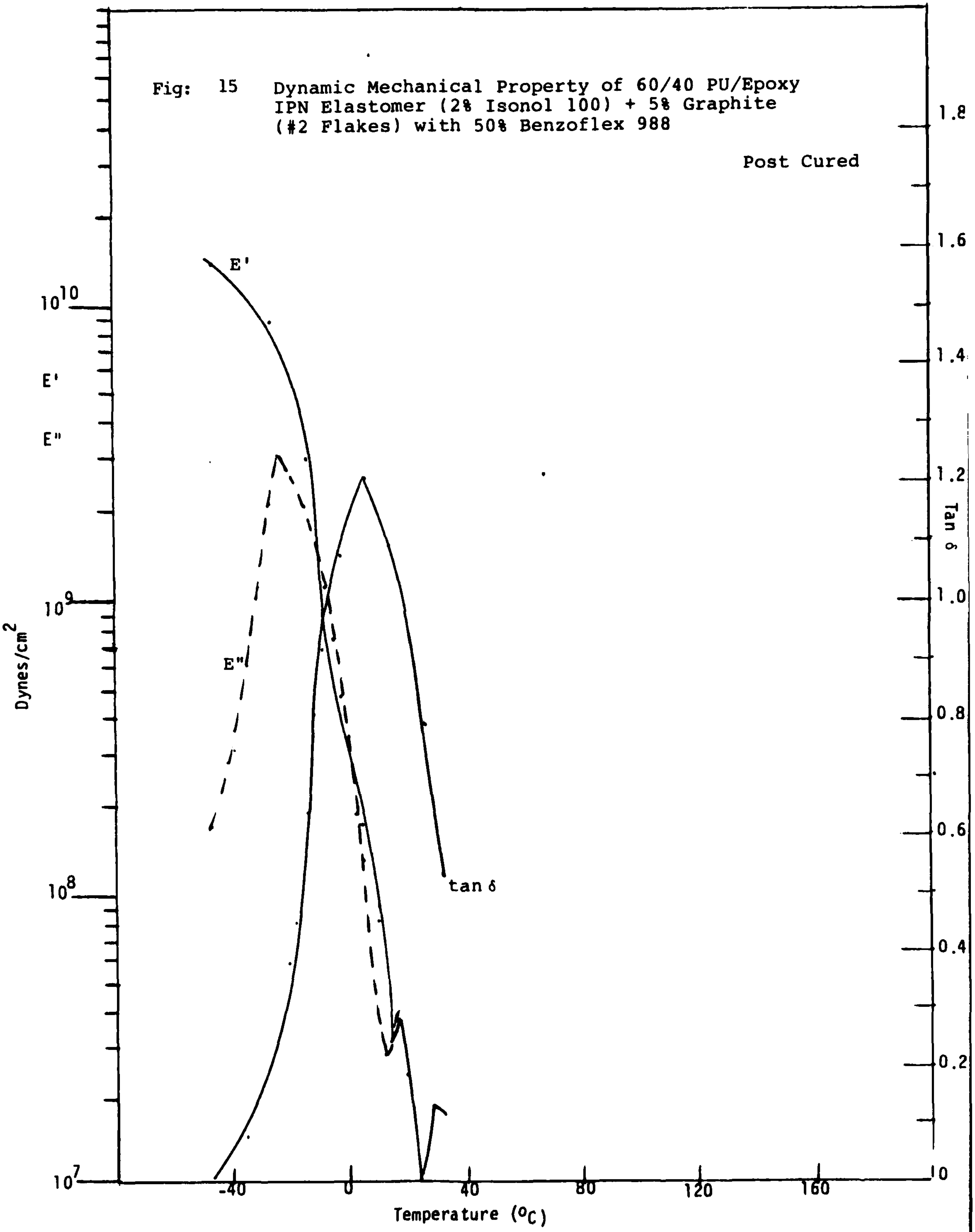


Fig: 15 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) + 5% Graphite (#2 Flakes) with 50% Benzoflex 988

Post Cured



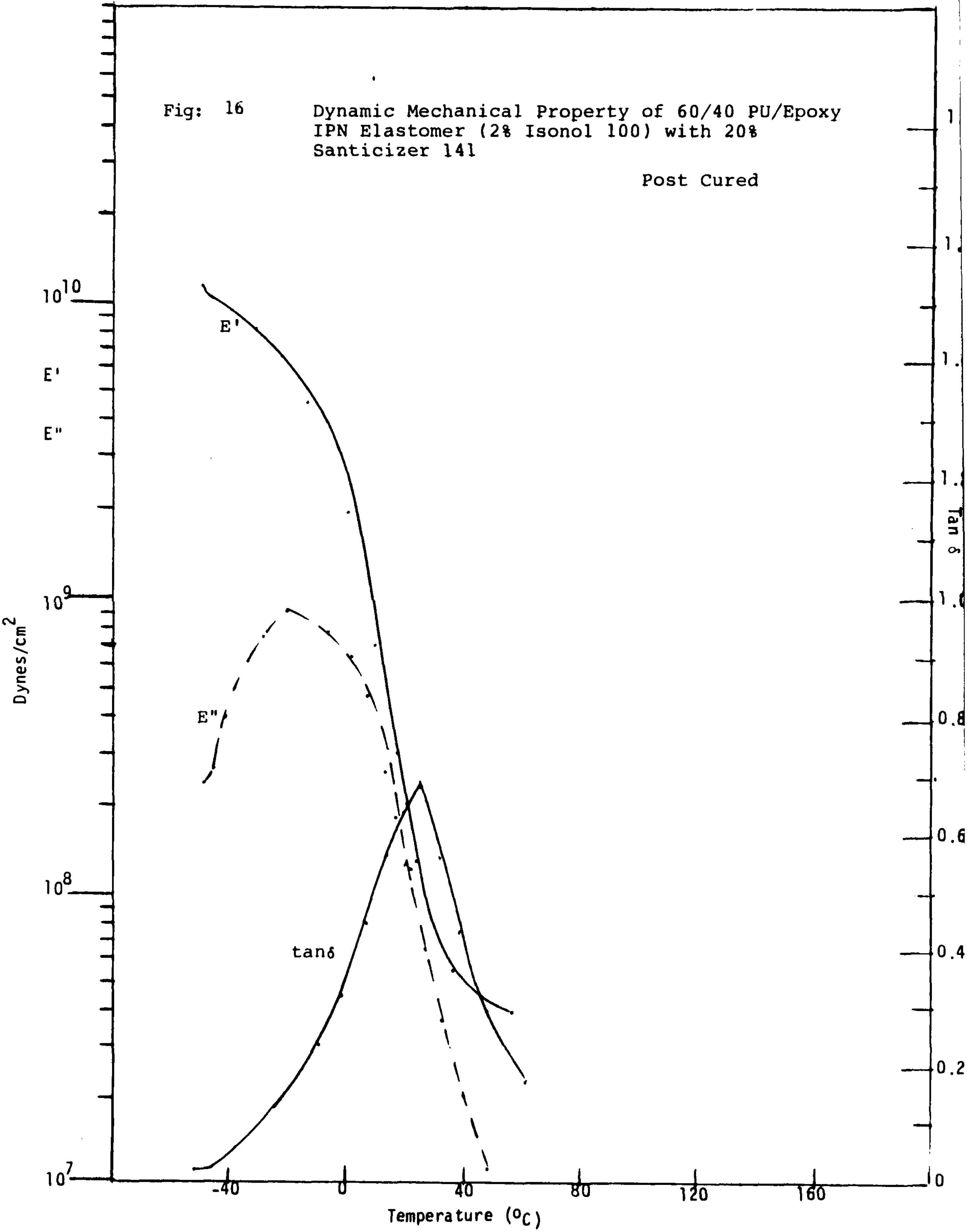


Fig: 16 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 20% Santicizer 141
Post Cured
E'
E"
tanδ
Dyne s/cm²
Tan δ
Temperature (°C)
-40
0
40
80
120
160
10^{10}
10^{9}
10^{8}
10^{7}
0.8
0.6
0.4
0.2
0

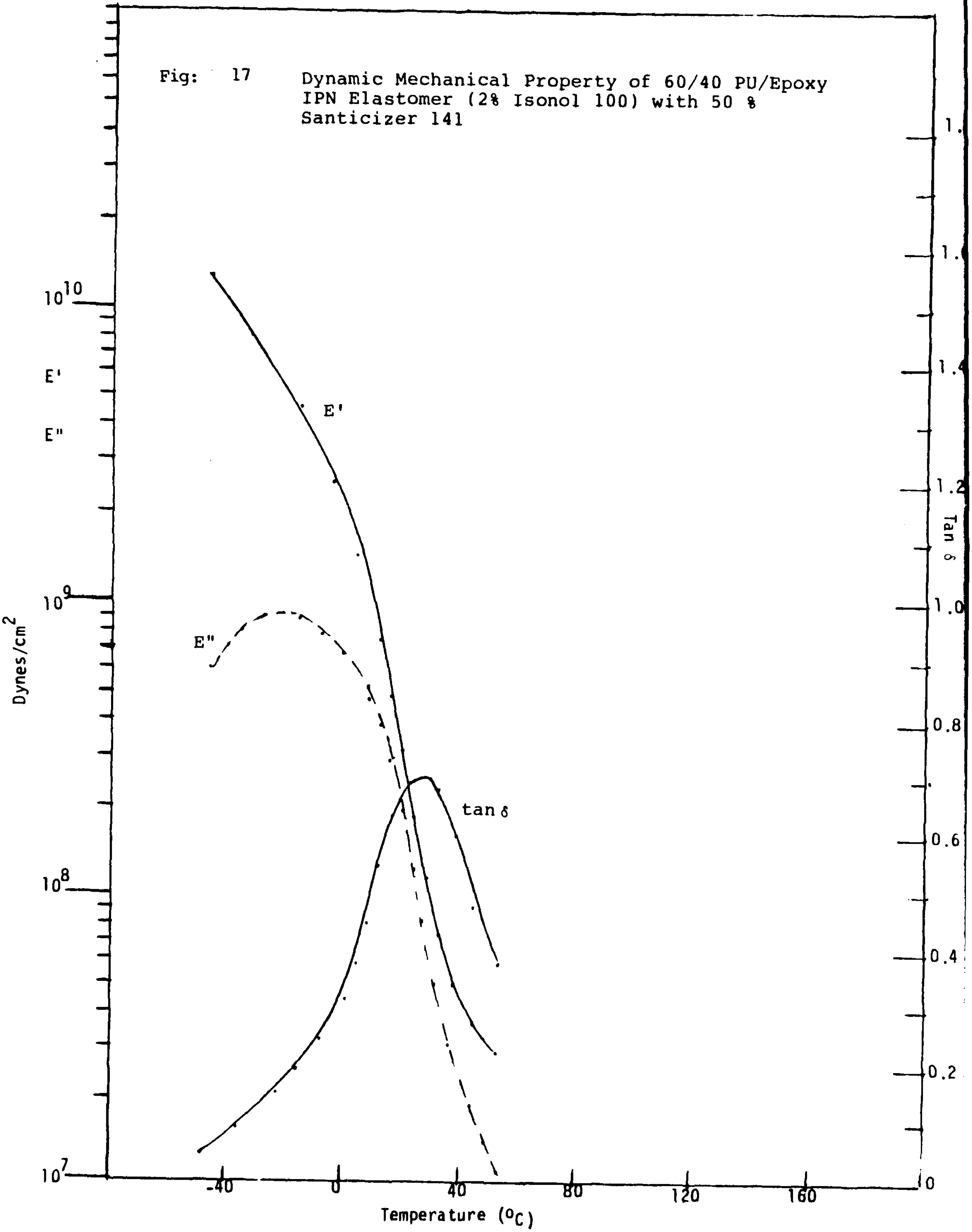


Fig: 17 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 50 % Santicizer 141
10^{10}
E'
E"
10^9
10^8
10^7
Dynes/cm^2
E'
E"
tan δ
-40
0
40
80
120
160
Temperature (^oC)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Tan δ

Fig: 18 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 20% Santicizer 148

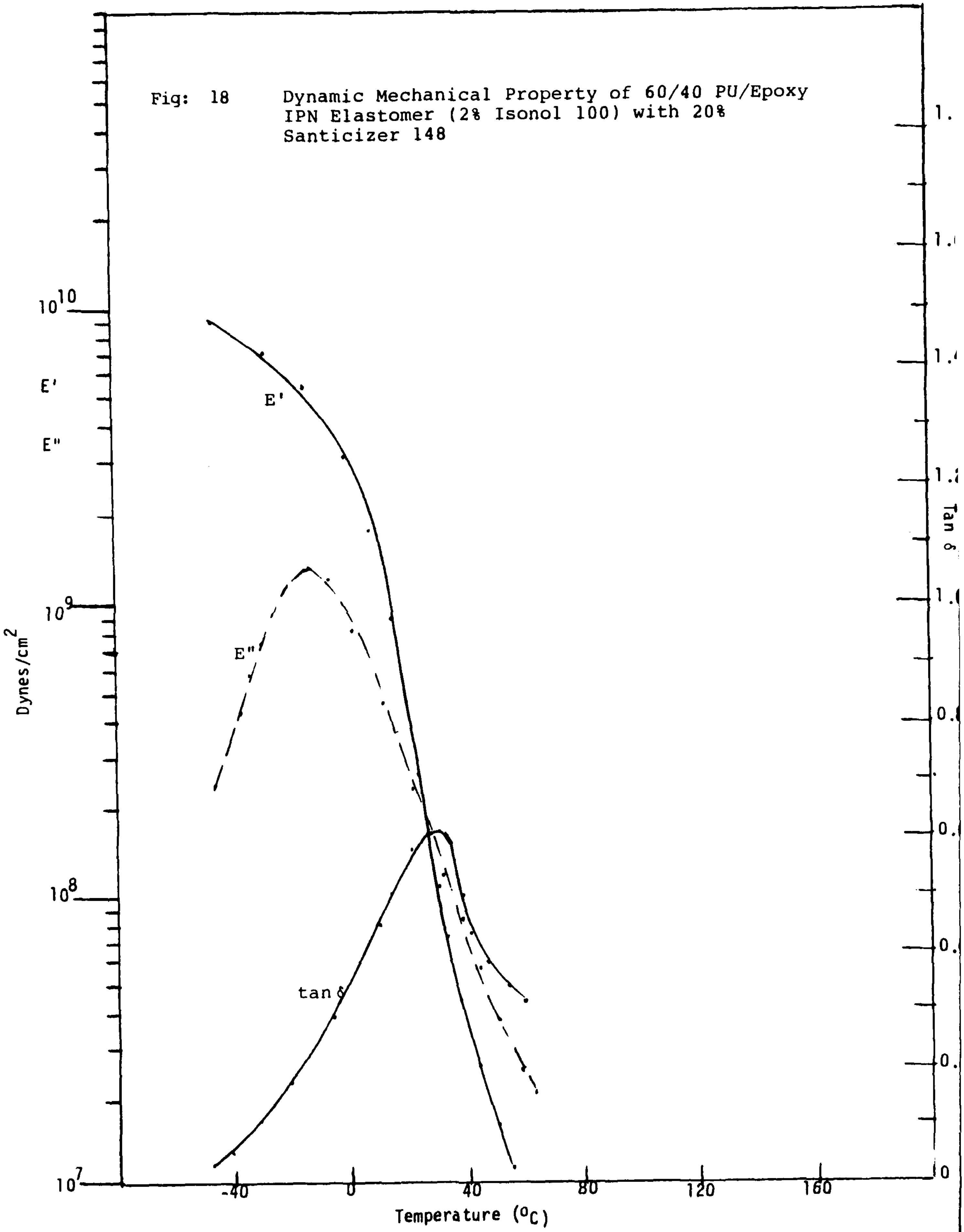
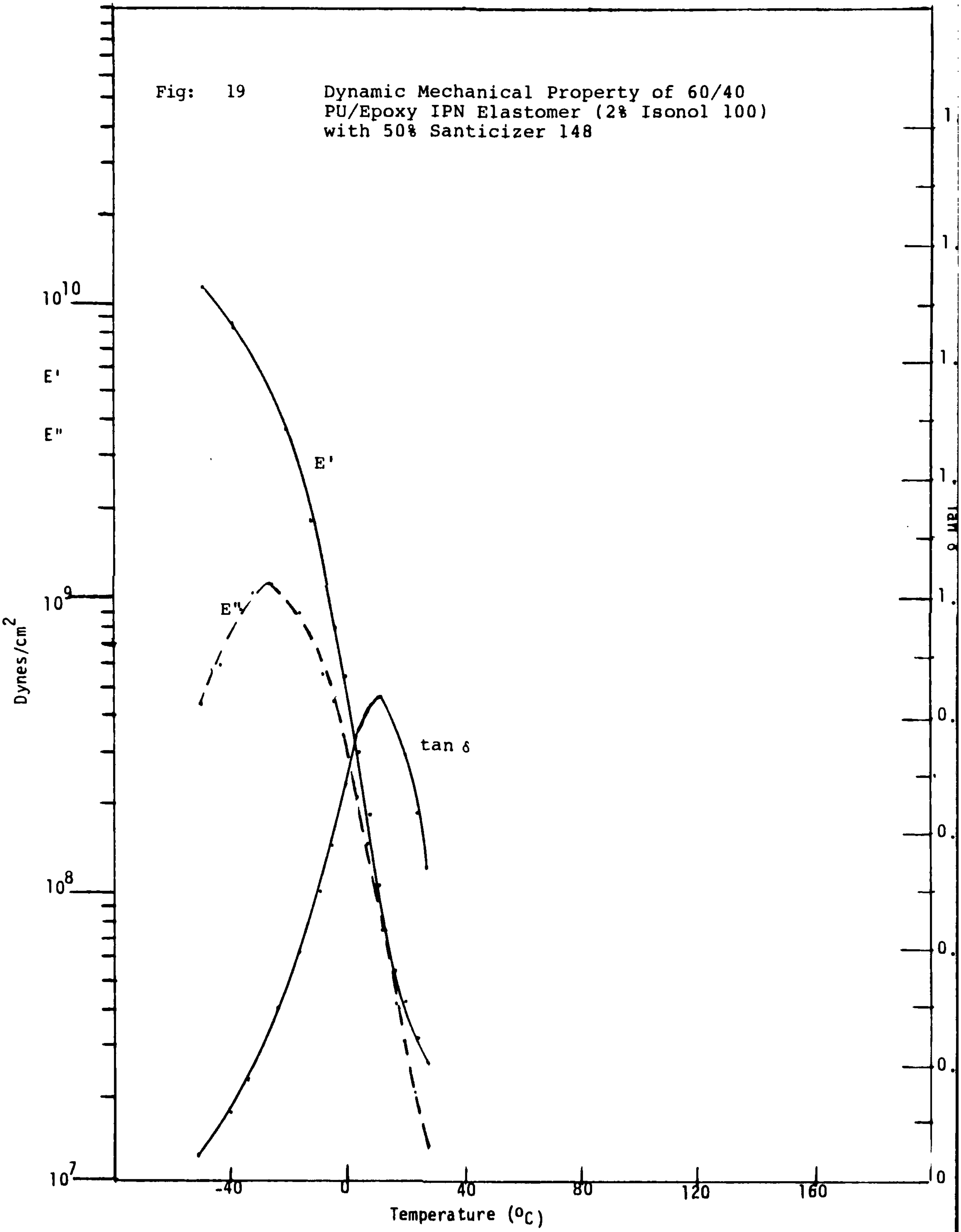


Fig: 19 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 50% Santicizer 148



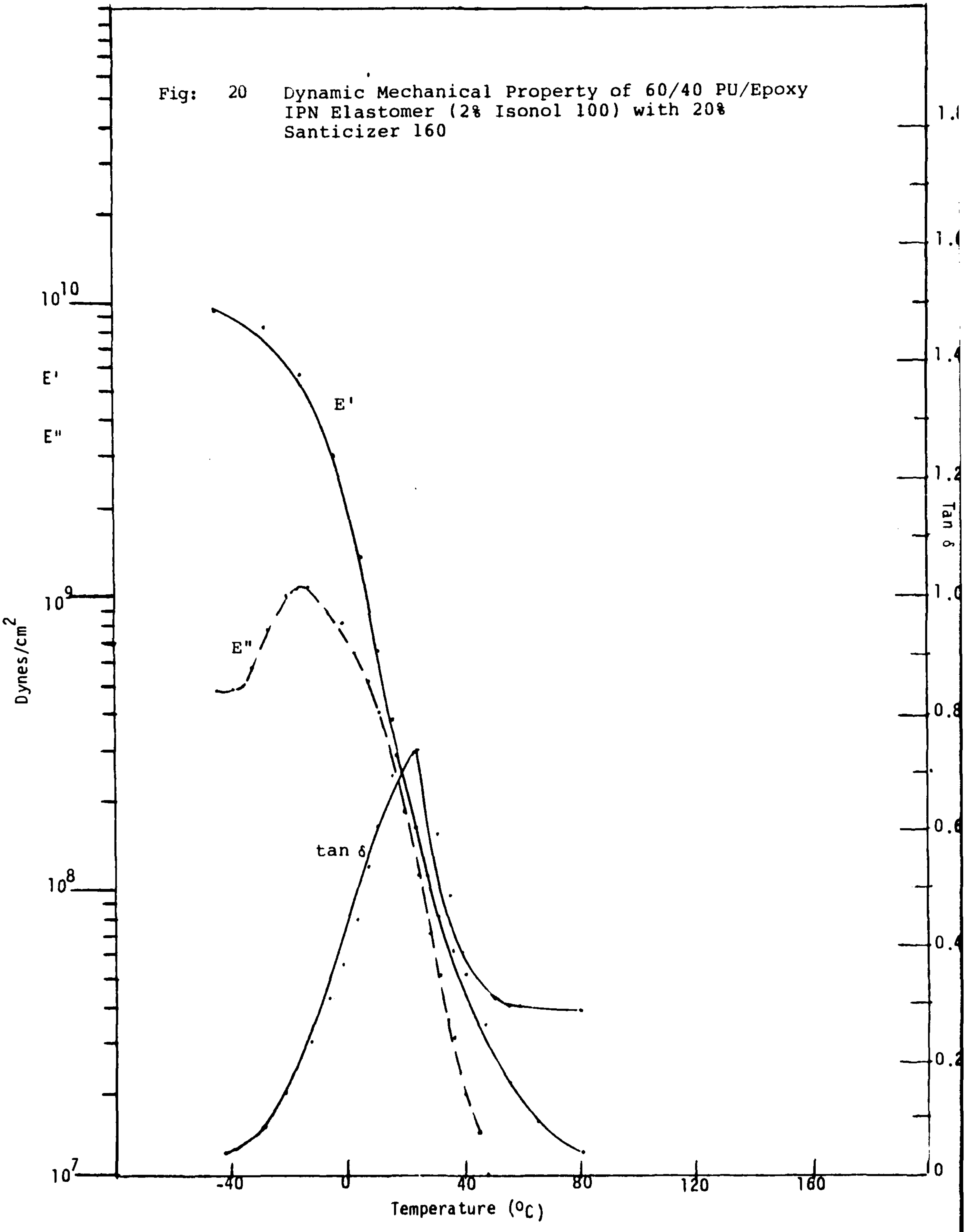


Fig: 20 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 20% Santicizer 160
E'
E"
tan δ
E'
E"
Dyne s/cm²
10¹⁰
10⁹
10⁸
10⁷
-40
0
40
80
120
160
Temperature (°C)
Tan δ
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8

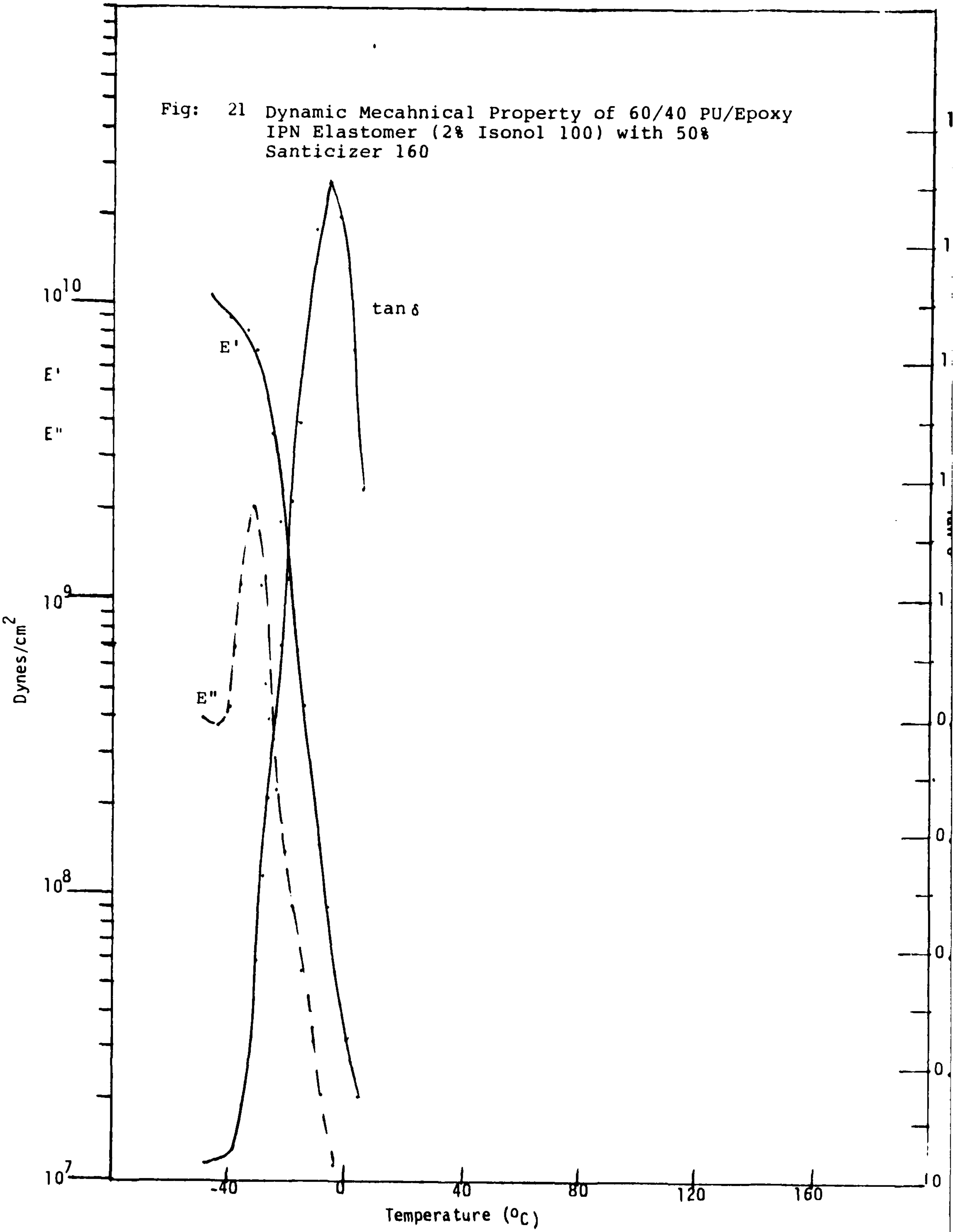


Fig: 21 Dynamic Mecahnical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 50% Santicizer 160
tan δ
E'
E"
10^{10}
10^{9}
10^{8}
10^{7}
Dynes/cm^2
-40
0
40
80
120
160
Temperature (^oC)

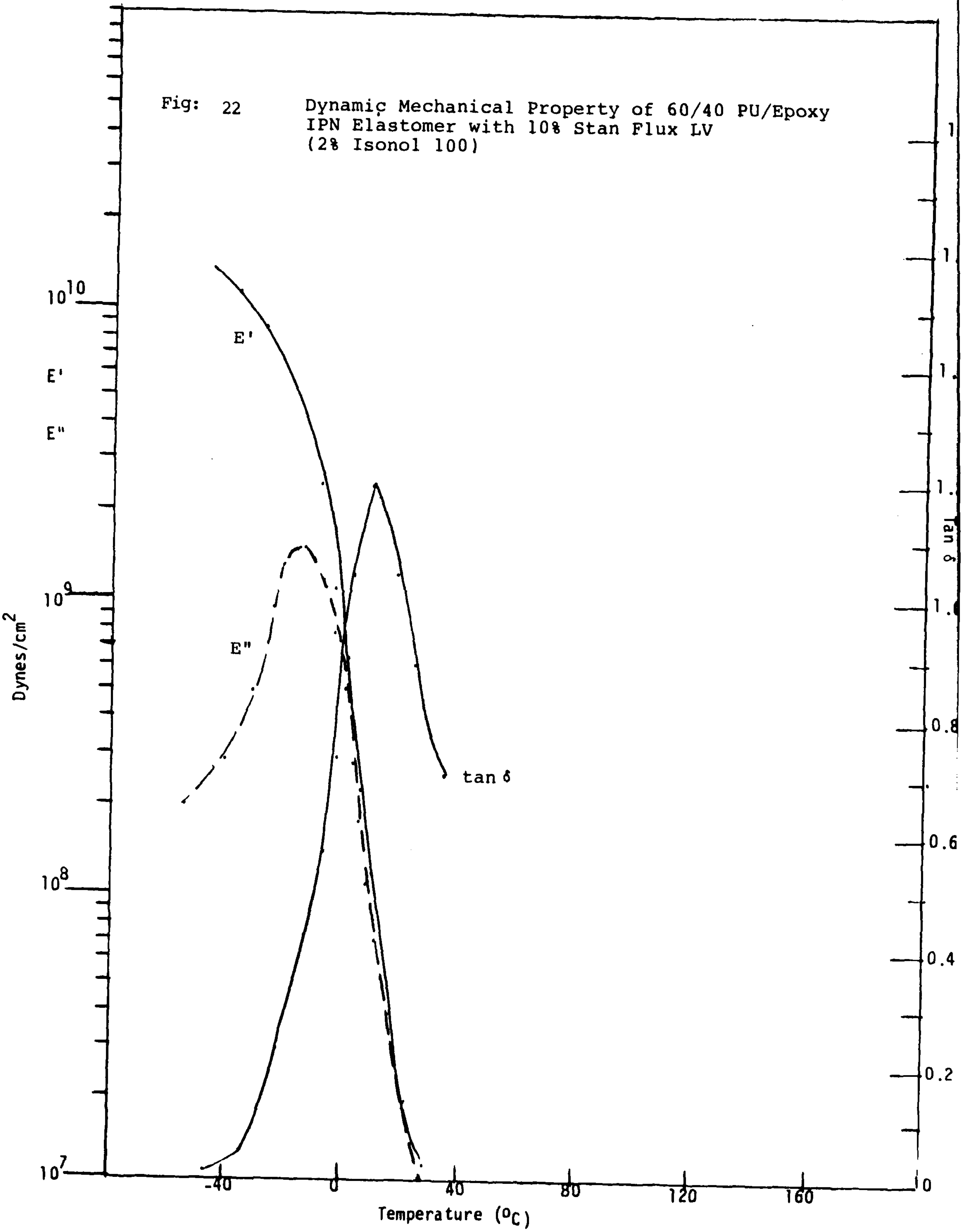


Fig: 22 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer with 10% Stan Flux LV (2% Isonol 100)
10^{10}
10^{9}
10^{8}
10^{7}
E'
E"
Dynes/cm^2
E'
E"
tan δ
-40
0
40
80
120
160
Temperature (^{o}C)
0.8
0.6
0.4
0.2
0
tan δ

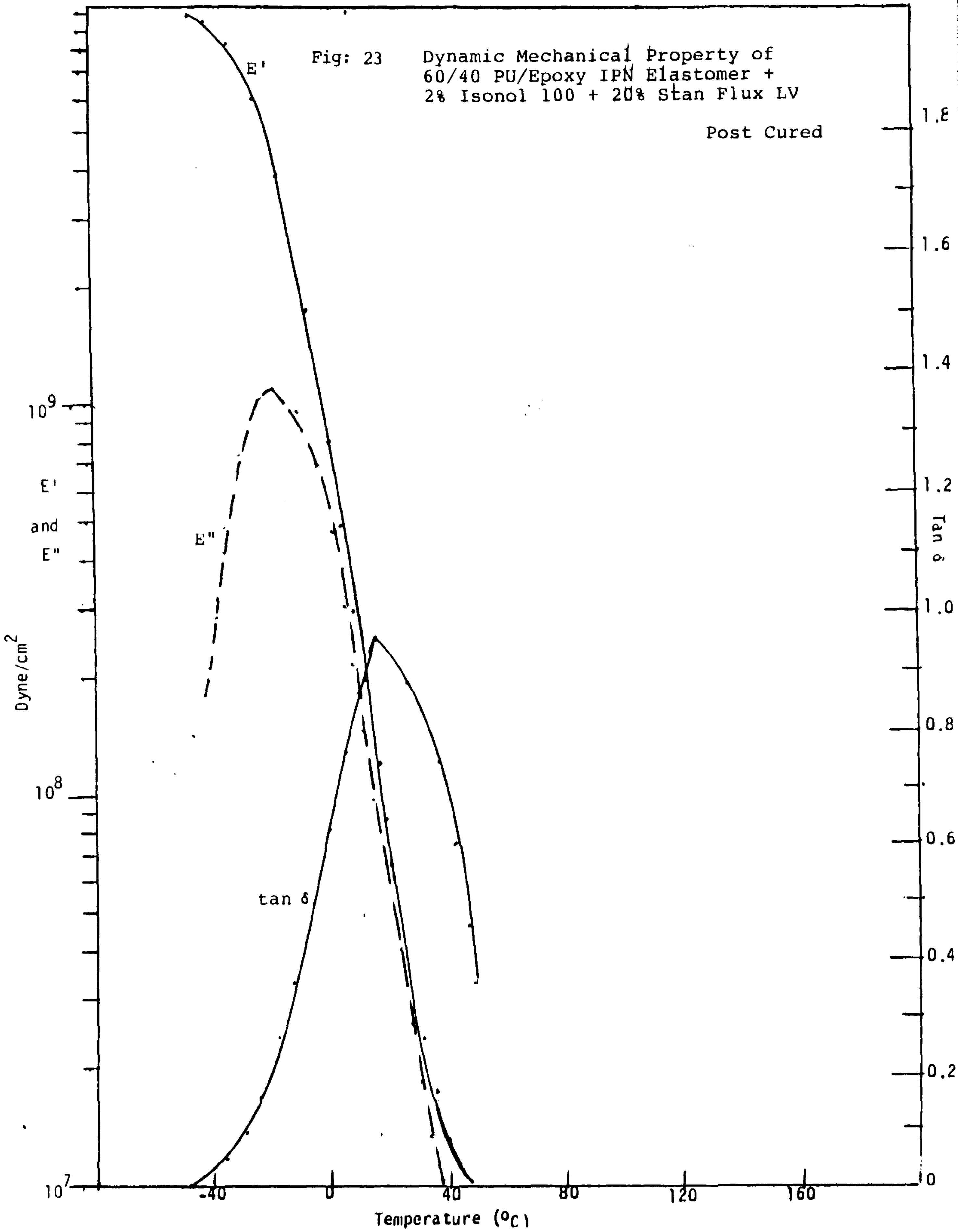


Fig: 23 Dynamic Mechanical Property of
60/40 PU/Epoxy IPN Elastomer +
2% Isonol 100 + 20% Stan Flux LV
Post Cured
E'
E"
tan δ
E' and E"
Dyne/cm^2
10^9
10^8
10^7
Tan δ
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
-40
0
40
80
120
160
Temperature (^oC)

Fig: 24 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 20% TCP

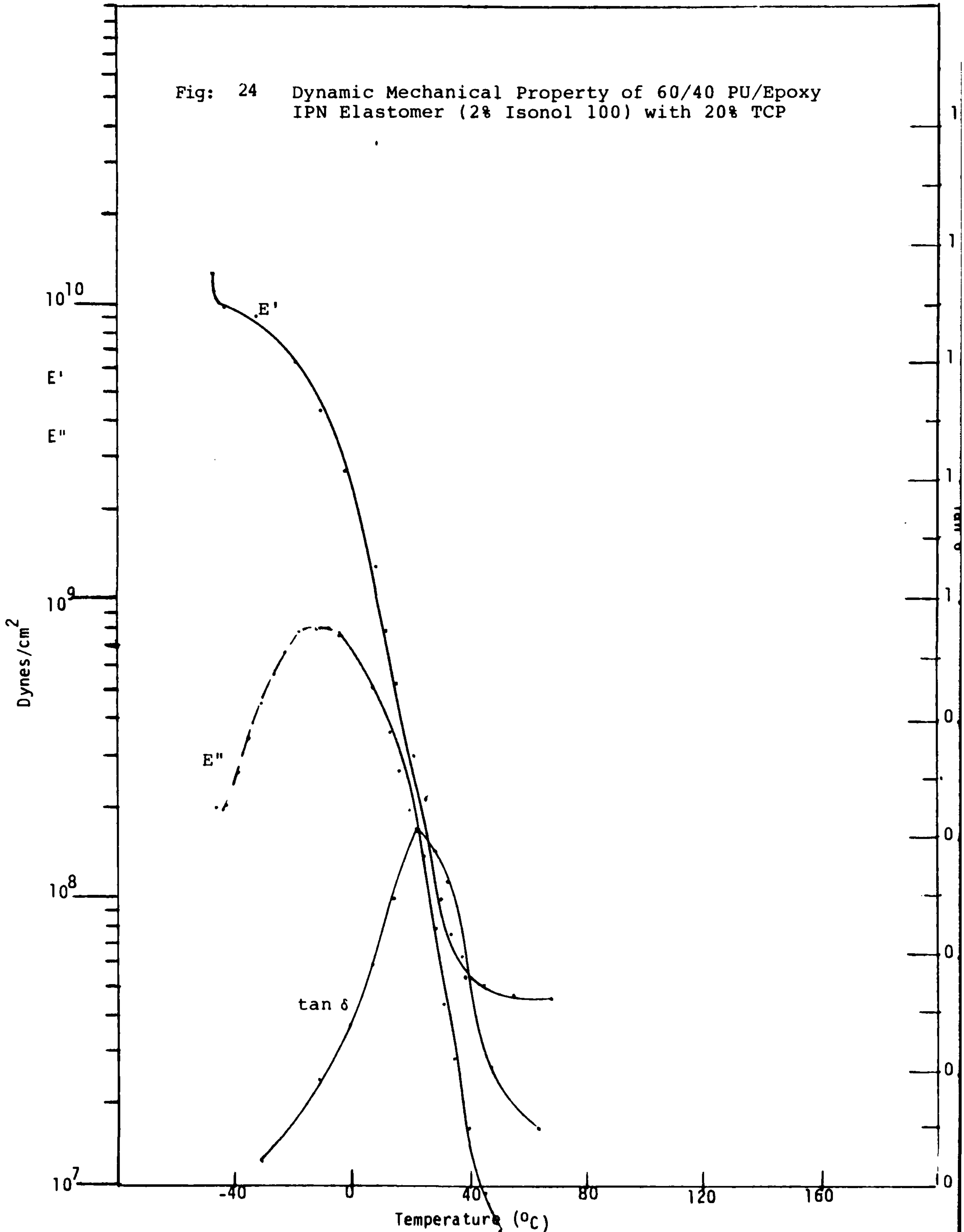


Fig: 25 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol 100) with 50% TCP

Post Cured

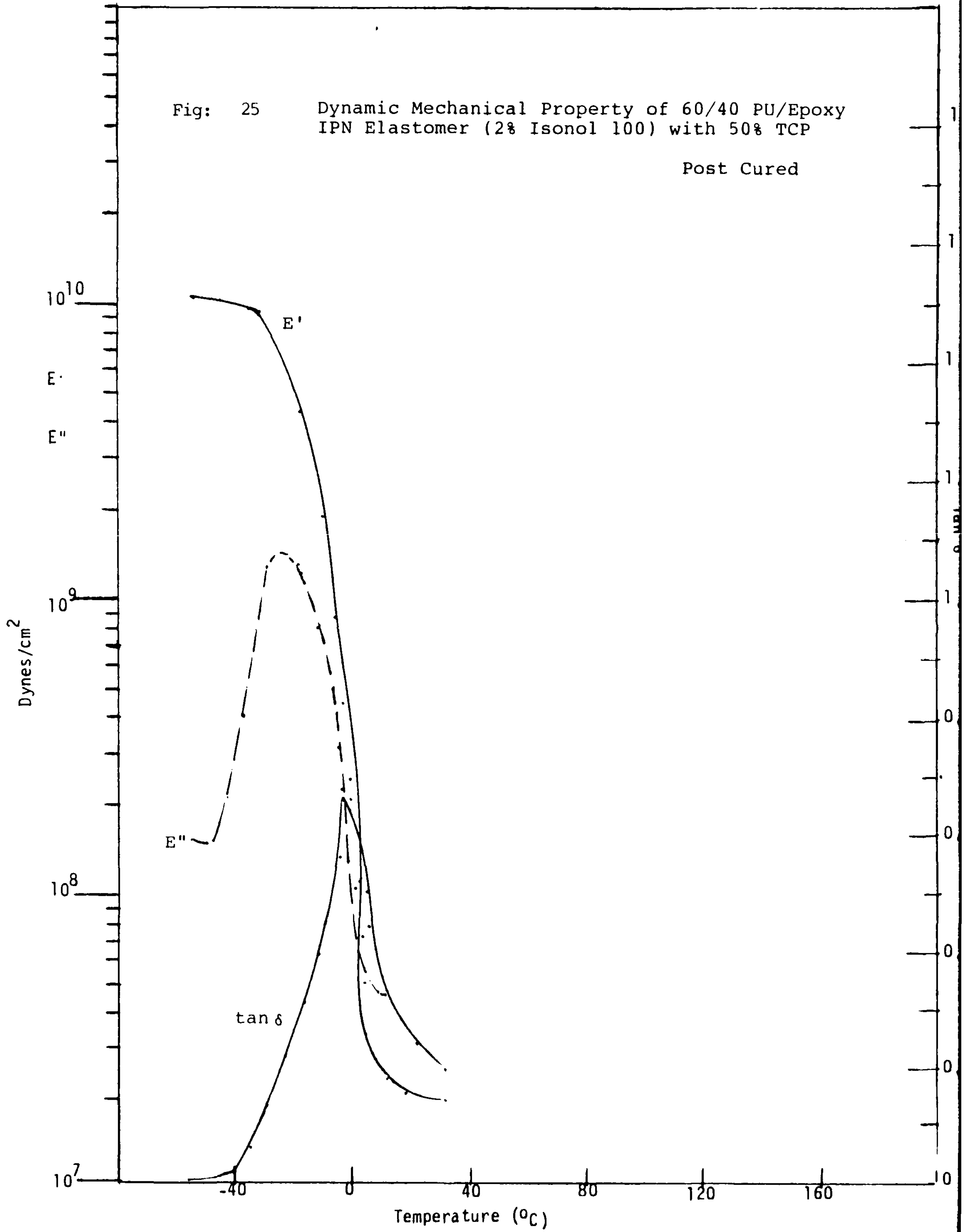


Fig: 26 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN using 20% Santicizer 148, based on Foam Formulation (2% Isonol 100)

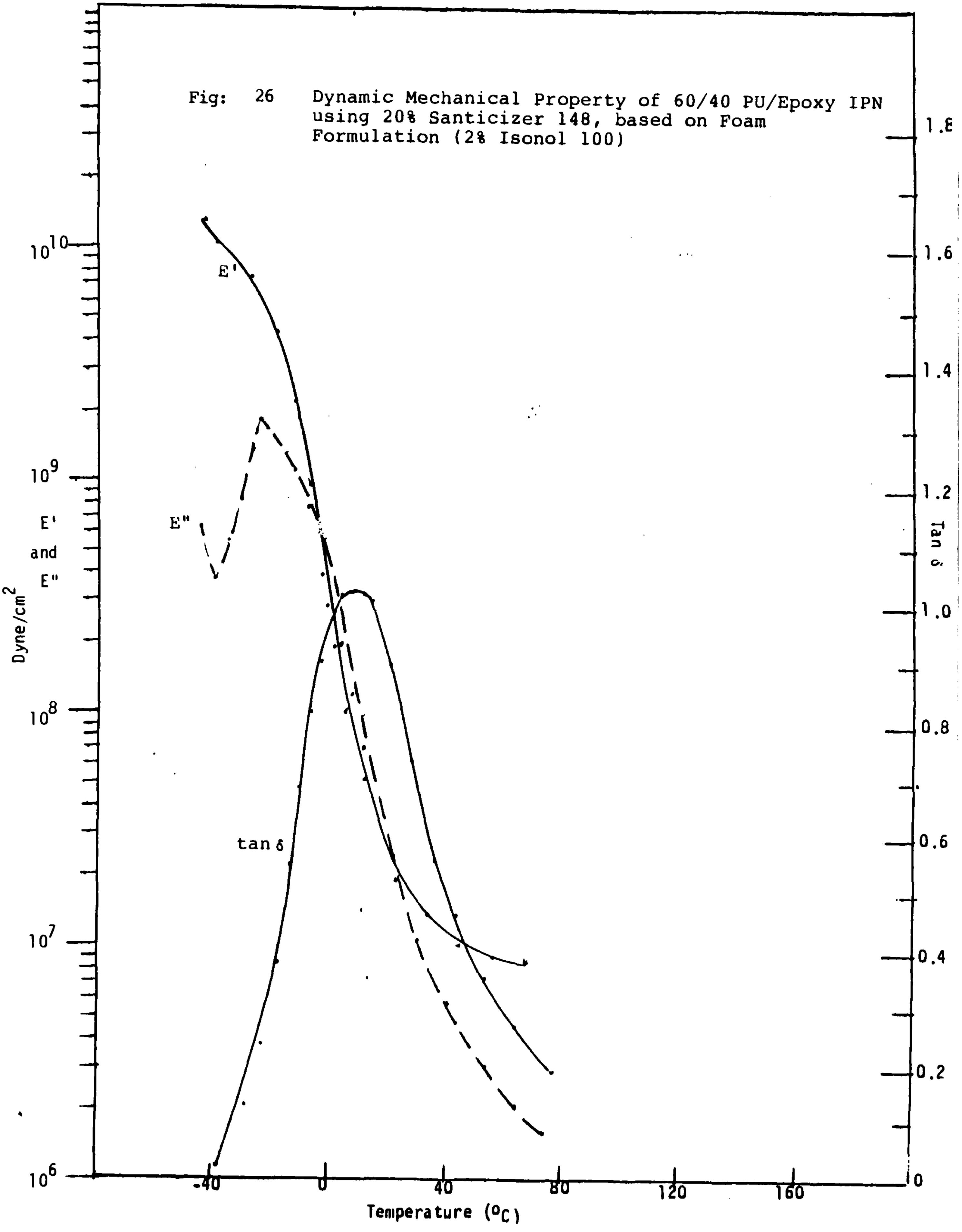
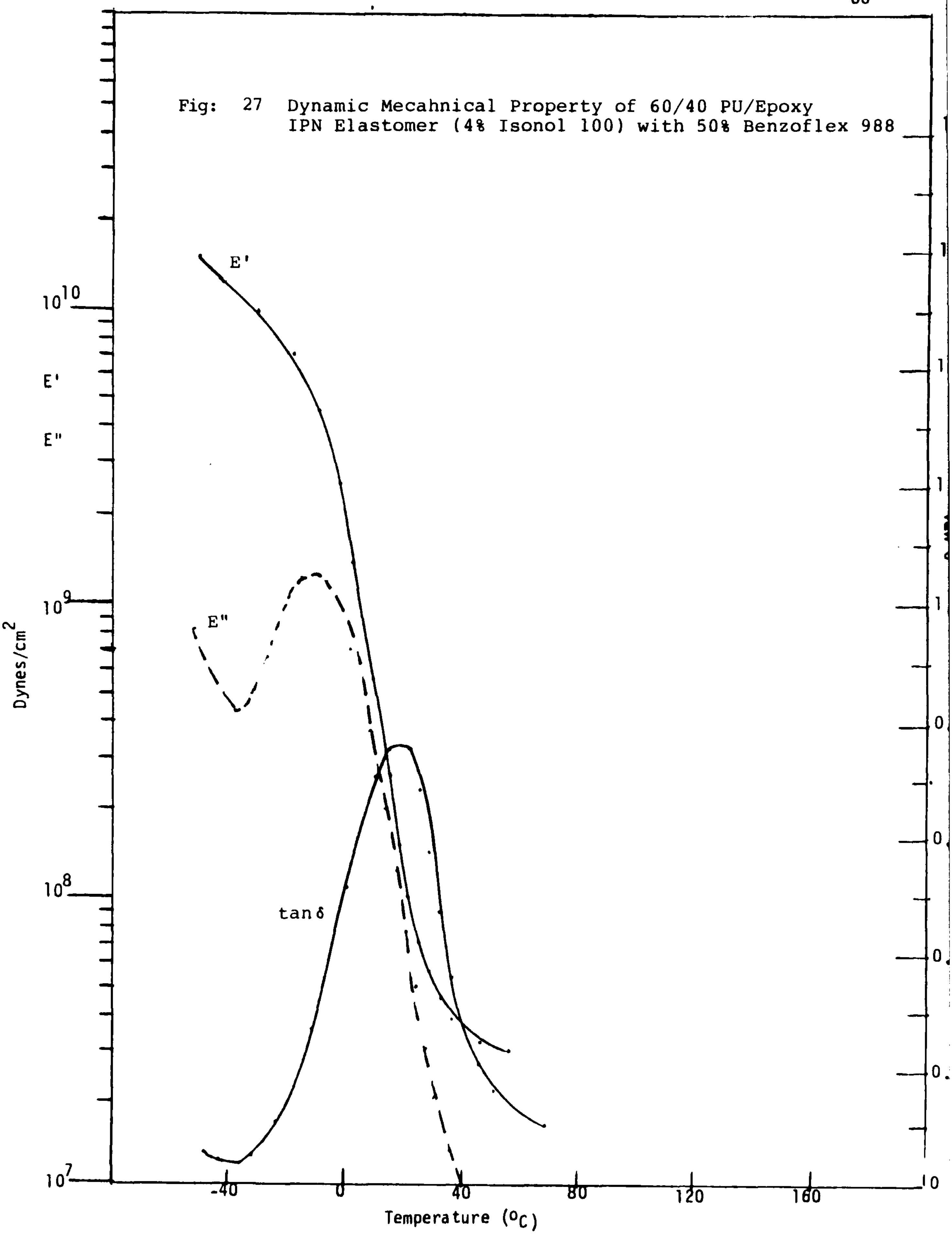


Fig: 27 Dynamic Mecahnical Property of 60/40 PU/Epoxy IPN Elastomer (4% Isonol 100) with 50% Benzoflex 988



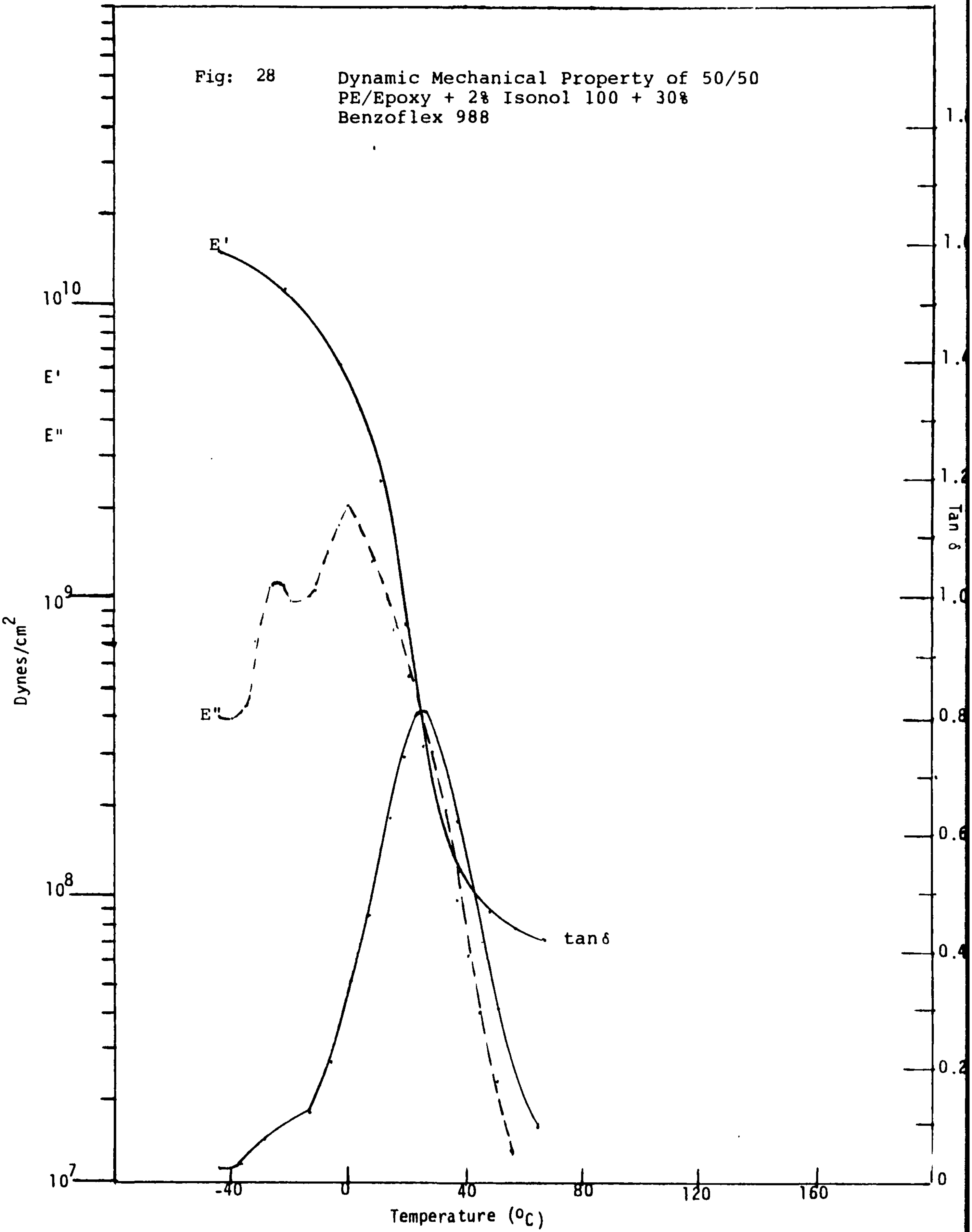


Fig: 28 Dynamic Mechanical Property of 50/50 PE/Epoxy + 2% Isonol 100 + 30% Benzoflex 988
E'
E"
tan δ
10^{10}
10^{9}
10^{8}
10^{7}
E'
E"
Dynes/cm^2
-40
0
40
80
120
160
Temperature (^oC)
1.0
0.8
0.6
0.4
0.2
0
Tan δ

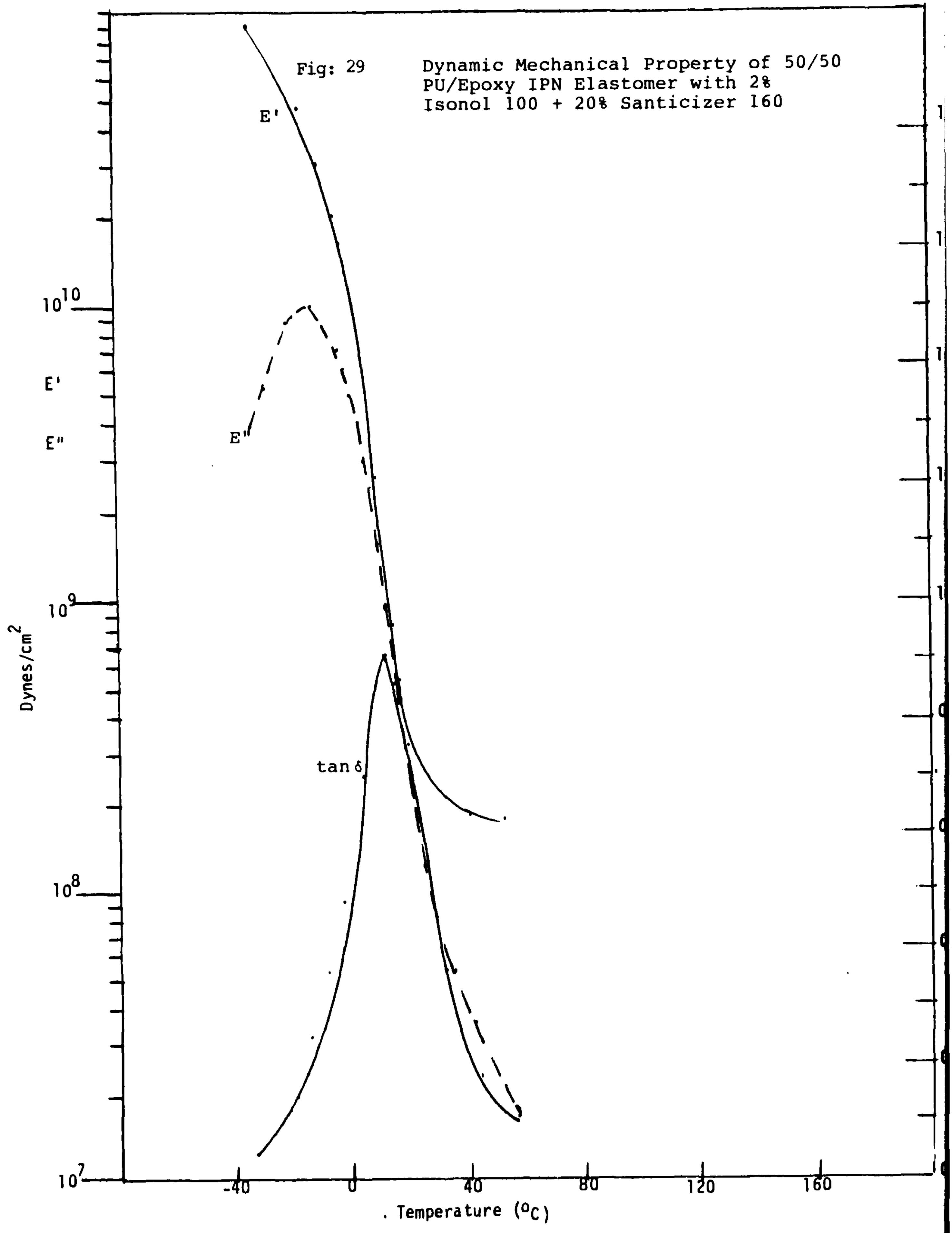


Fig: 29 Dynamic Mechanical Property of 50/50 PU/Epoxy IPN Elastomer with 2% Isonol 100 + 20% Santicizer 160
E'
E"
tan δ
10^{10}
10^{9}
10^{8}
10^{7}
E'
E"
Dynes/cm^2
-40
0
40
80
120
160
Temperature (°C)

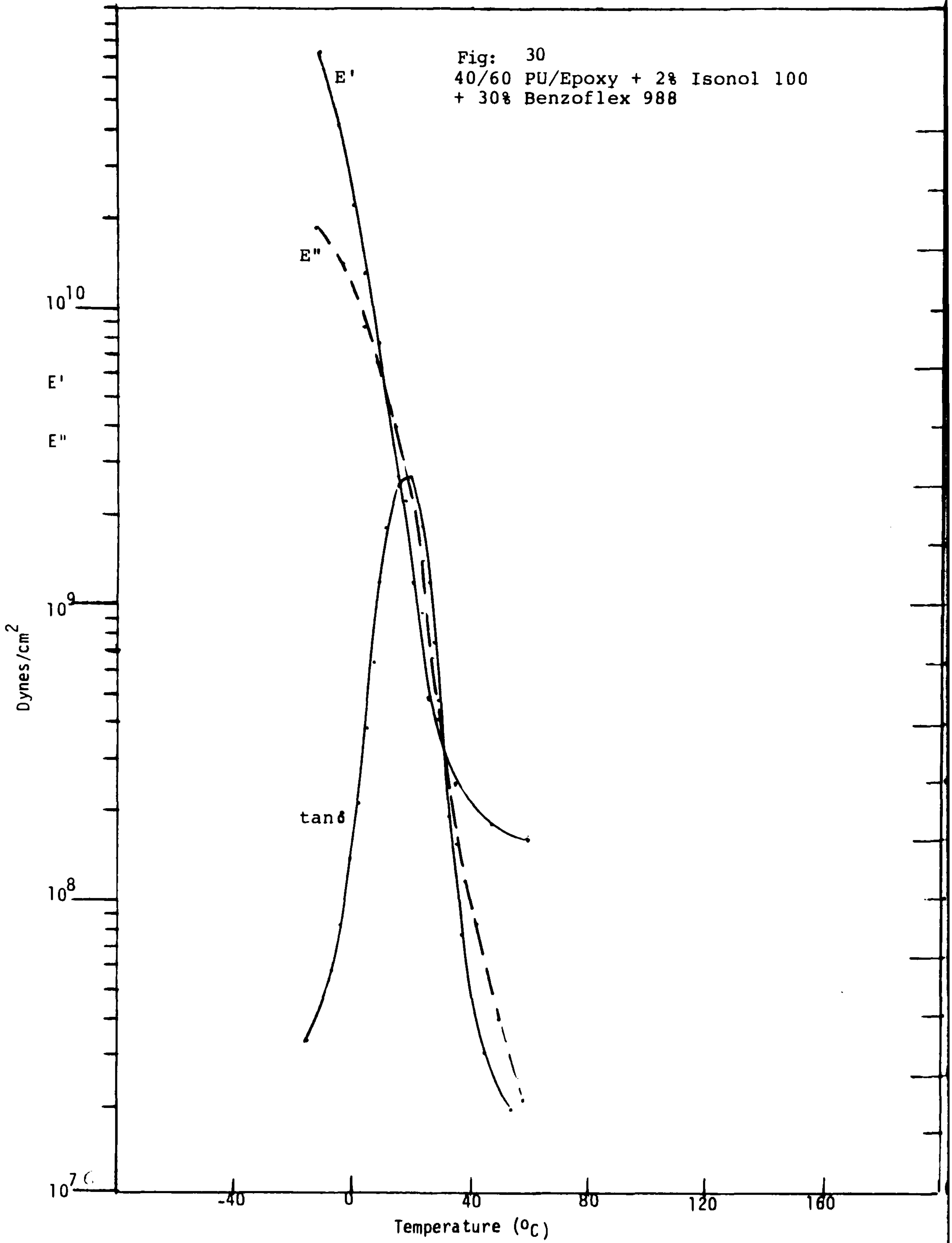


Fig: 30
40/60 PU/Epoxy + 2% Isonol 100
+ 30% Benzoflex 988
E'
E"
tanδ
10^{10}
10^{9}
10^{8}
10^{7}
E'
E"
Dynes/cm^2
-40
0
40
80
120
160
Temperature (^oC)

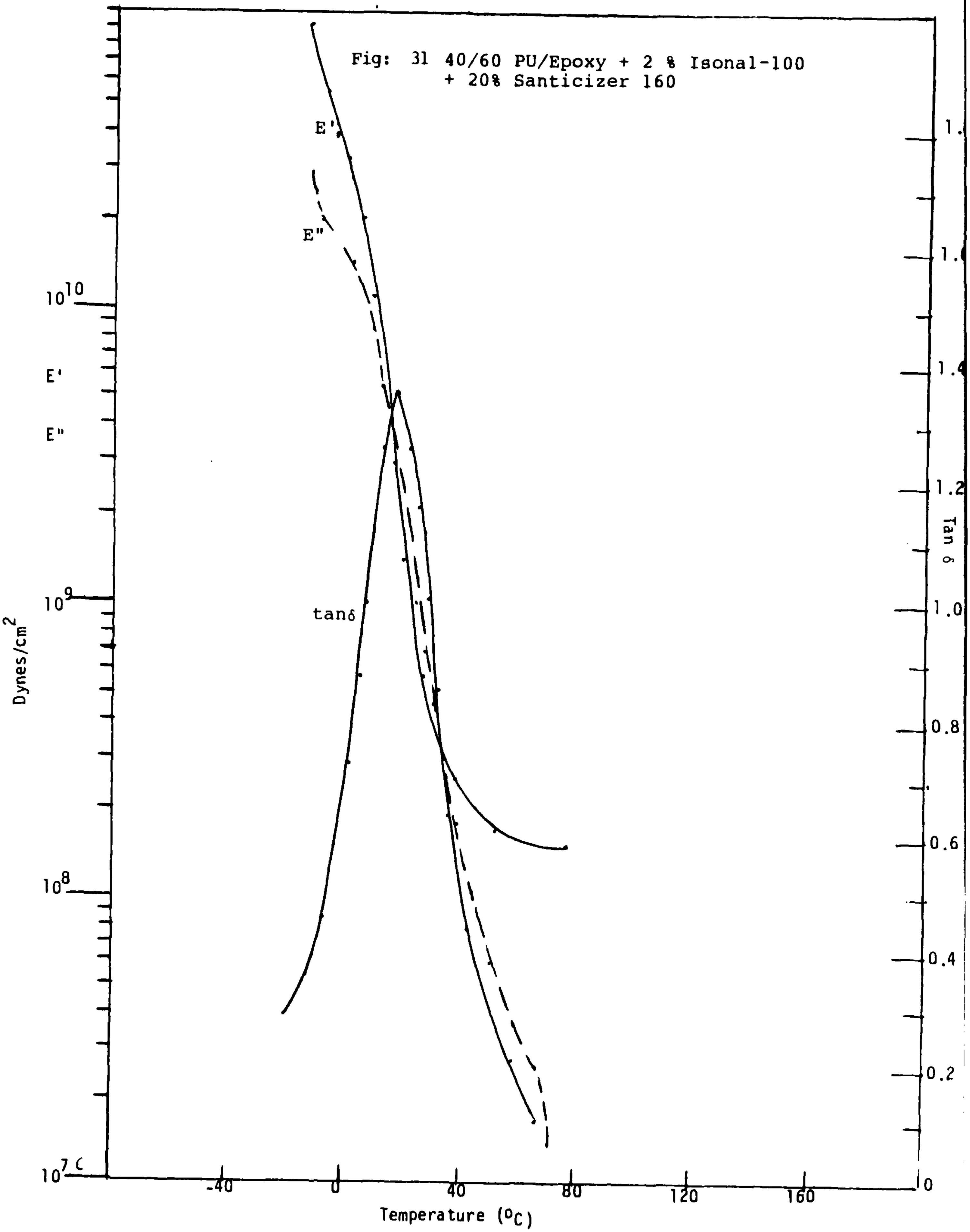


Fig: 31 40/60 PU/Epoxy + 2 % Isonal-100
+ 20% Santicizer 160
E'
E"
tanδ
10^{10}
10^{9}
10^{8}
10^{7}
E'
E"
Dynes/cm^2
-40
0
40
80
120
160
Temperature (^oC)
Tan δ
1.0
0.8
0.6
0.4
0.2
0
1.2

Fig: 32 Effect of Polyurethane/Epoxy Ratio on Performance of Plasticizer (i.e. 30% Benzoflex 9.88)

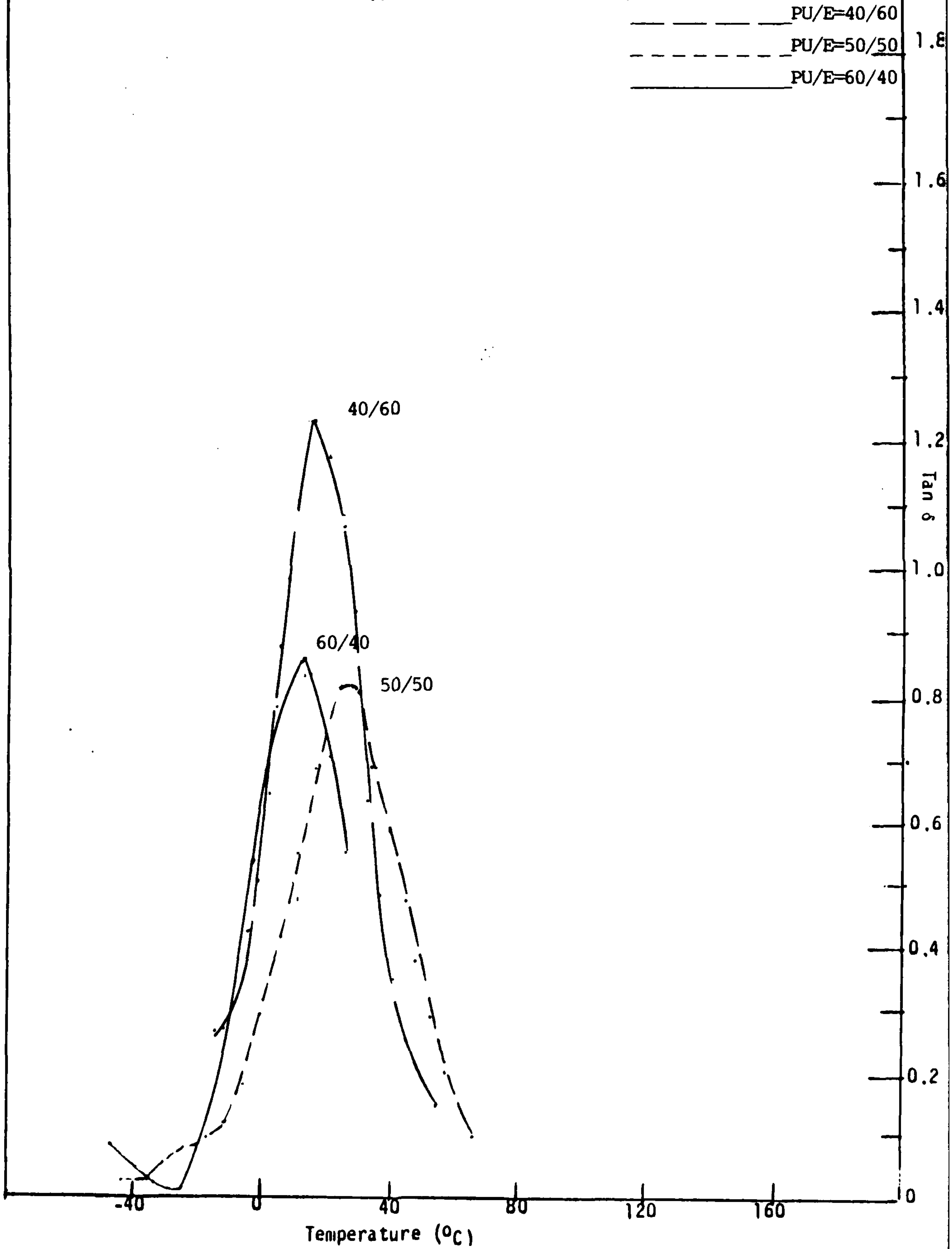
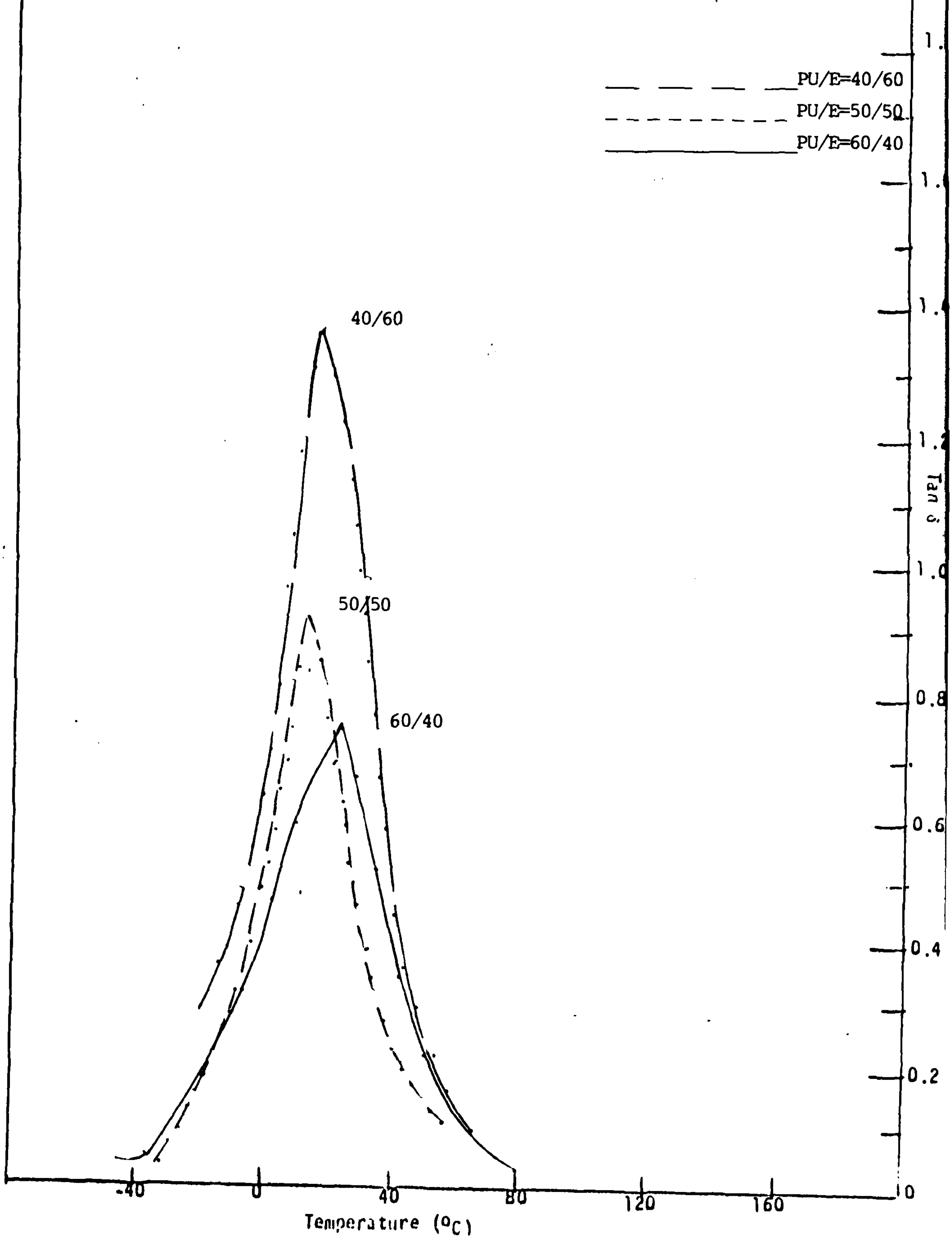


Fig: 33 Effect of Polyurethane/Epoxy Ratio on Performance of Plasticizer (i.e. 20% Santicizer - 160)



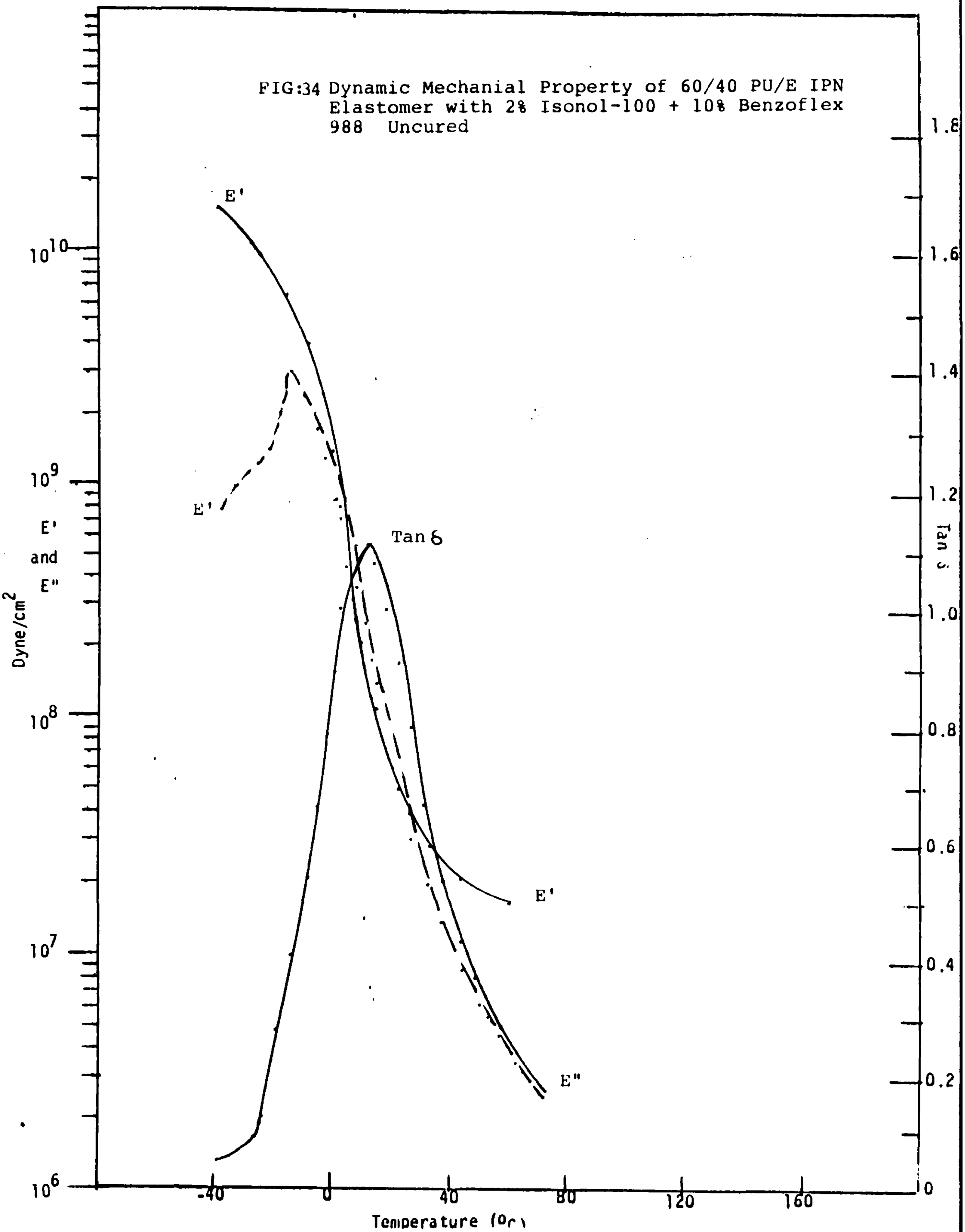


FIG:34 Dynamic Mechanial Property of 60/40 PU/E IPN Elastomer with 2% Isonol-100 + 10% Benzoflex 988 Uncured
E'
E'
Tan δ
E'
E"
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
E' and E"
Dyne/cm^2
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Tan δ
-40
0
40
80
120
160
Temperature

FIG: 35 Dynamic Mechanial Property of 60/40 PU/E + 2% Isonol-100 IPN Elastomer with 30% Bensoflex 988 Uncured

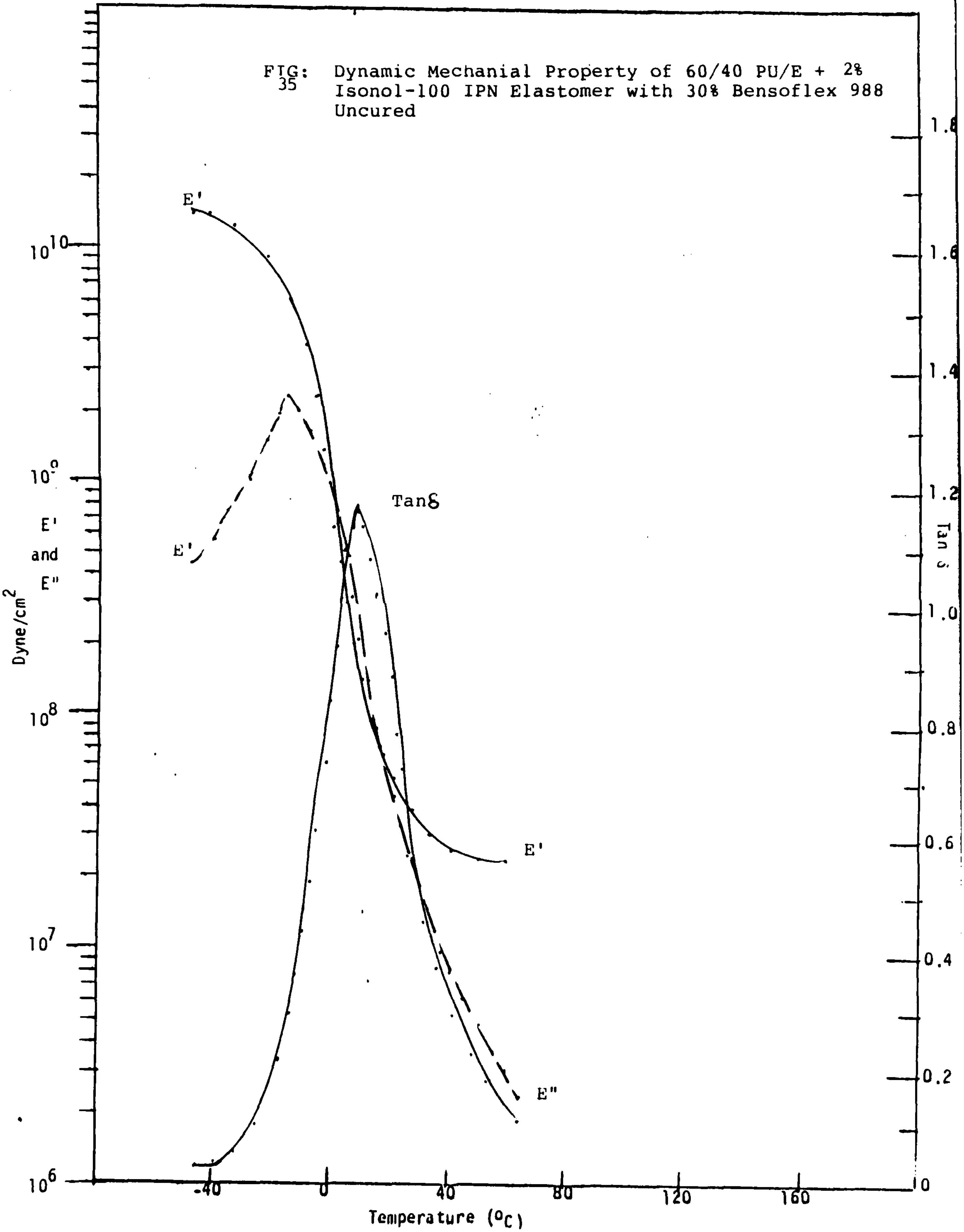


FIG: 36 Dynamic Mechanial Property of 60/40 PU/E IPN Elastomer with 2% Isonol-100 + 50% Benzoflex 988 Uncured

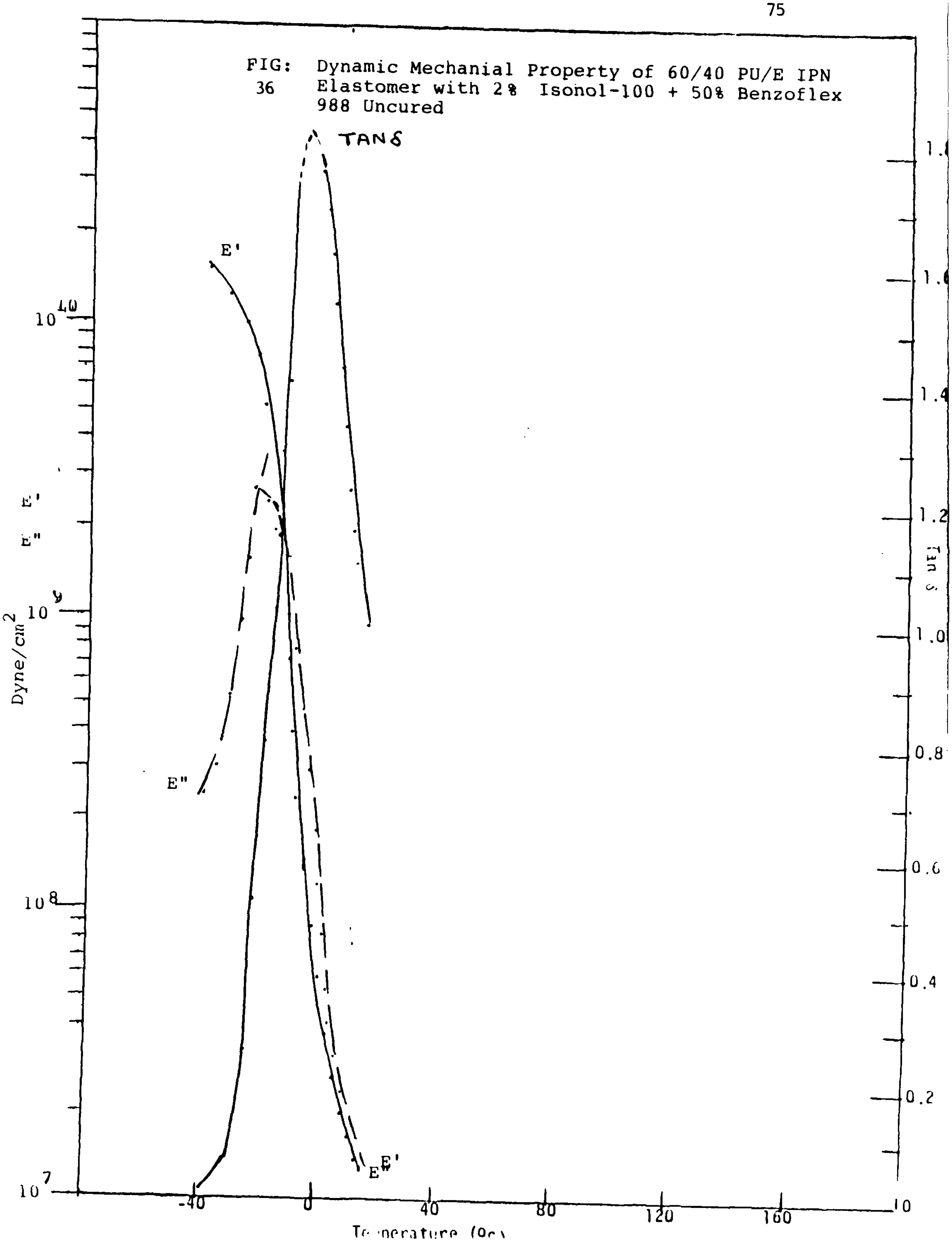


FIG: 37 Dynamic Mechanial Property of 60/40 PU/E IPN Elastomer (2% Isonol-100) with 5% Graphite (#2 Flakes) + 50% Benzoflex - 988 Uncured

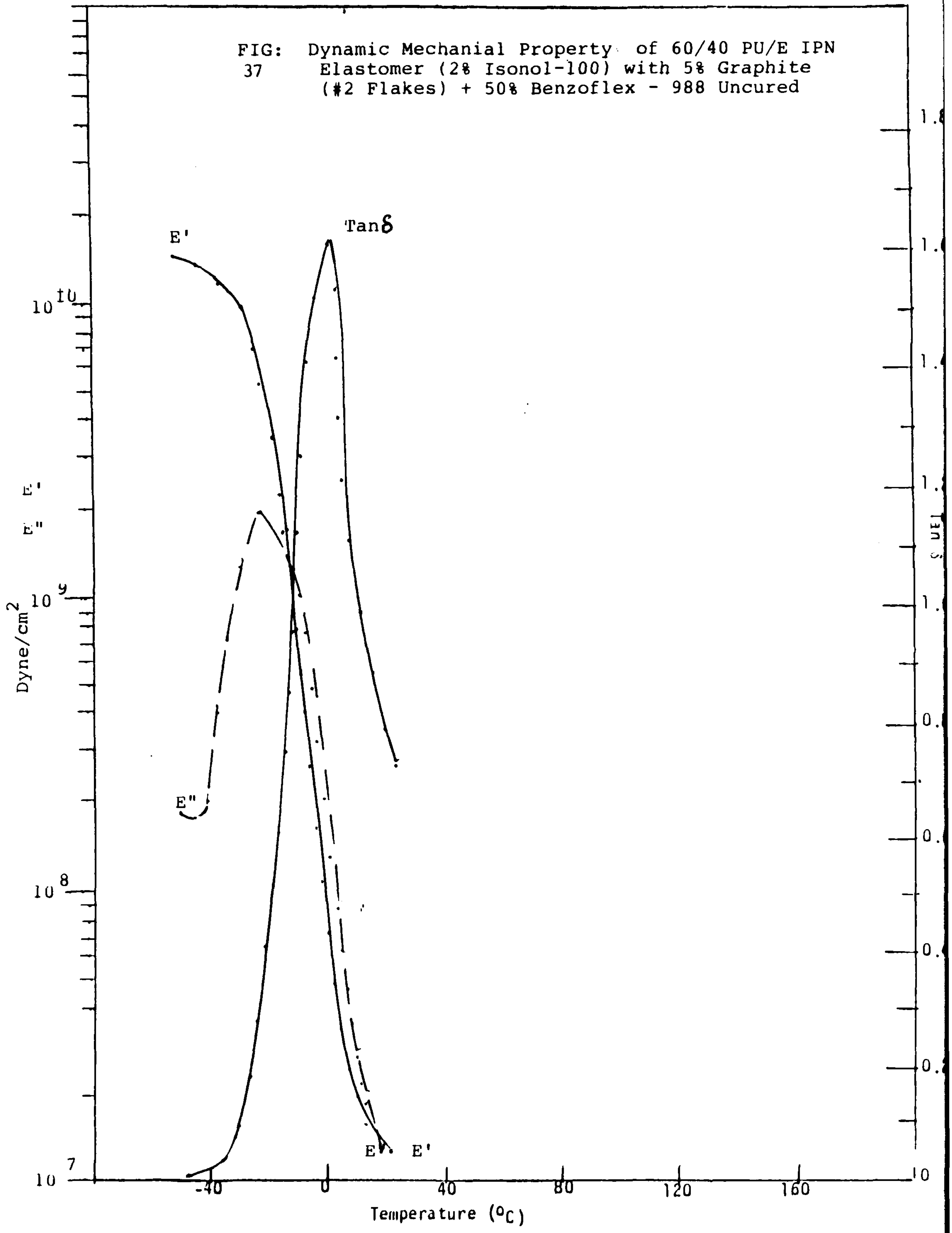


FIG: 38 Dynamic Mechanial Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol-100) with 20% Santicizer-141 Uncured

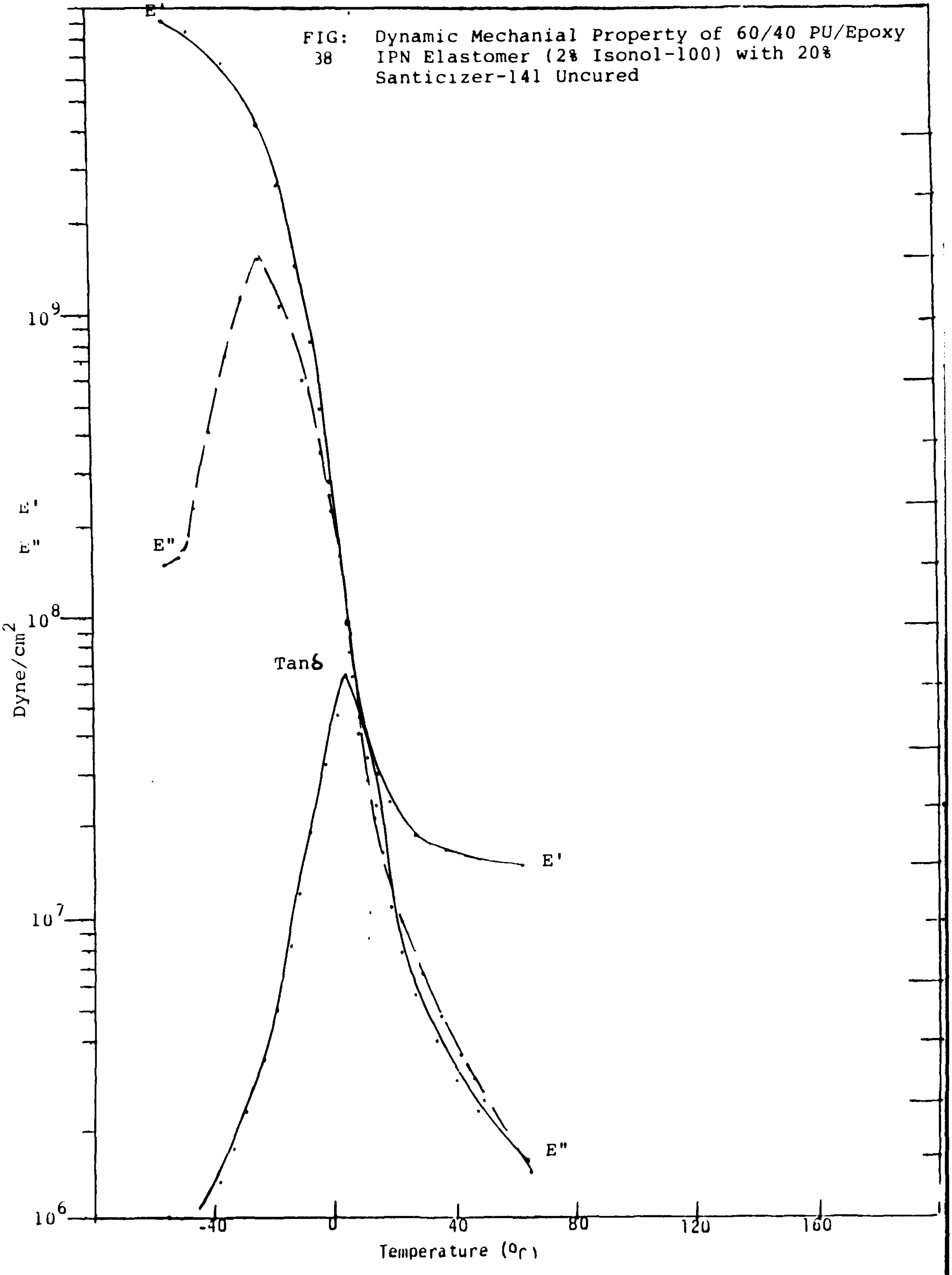
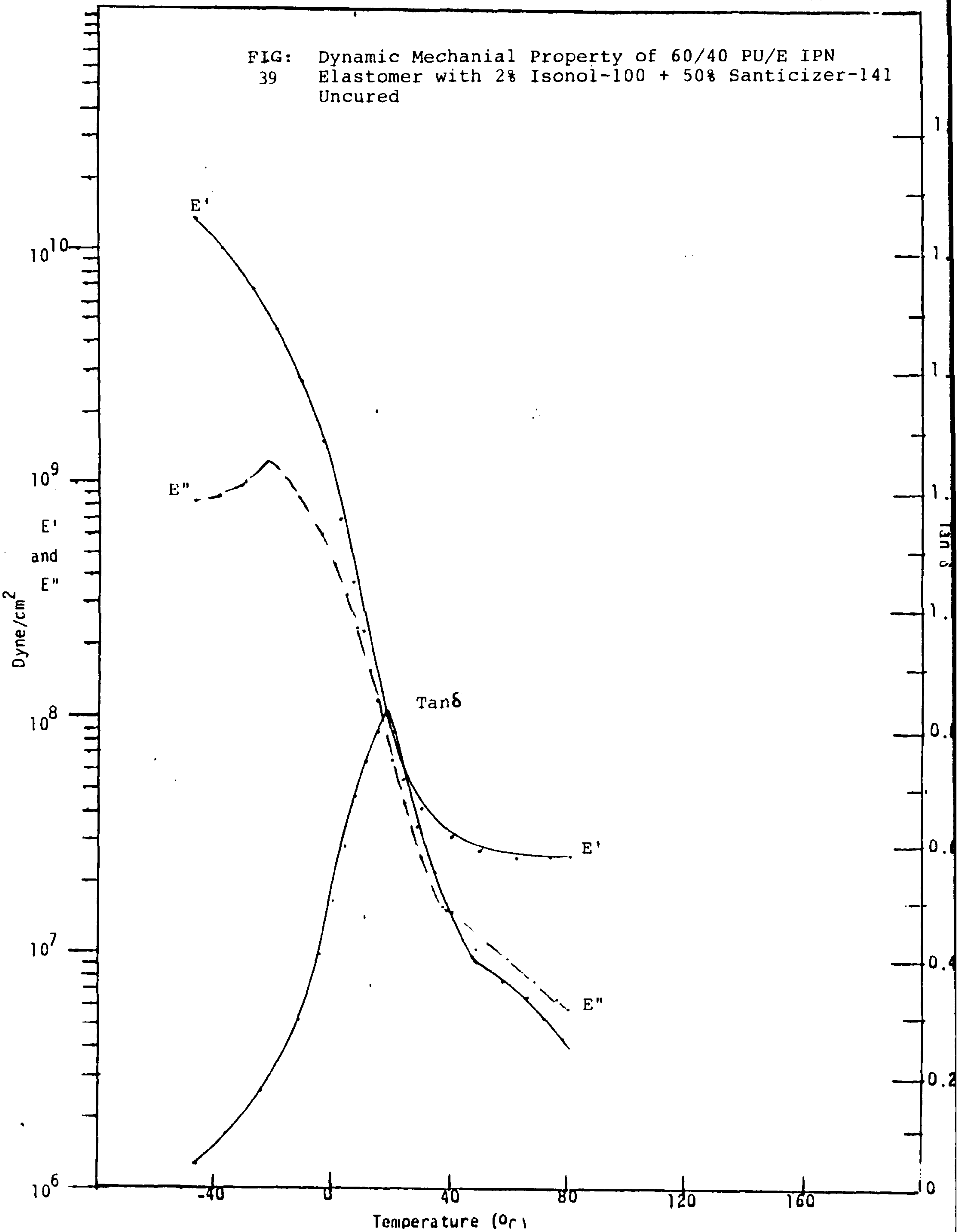


FIG: 39 Dynamic Mechanial Property of 60/40 PU/E IPN Elastomer with 2% Isonol-100 + 50% Santicizer-141 Uncured



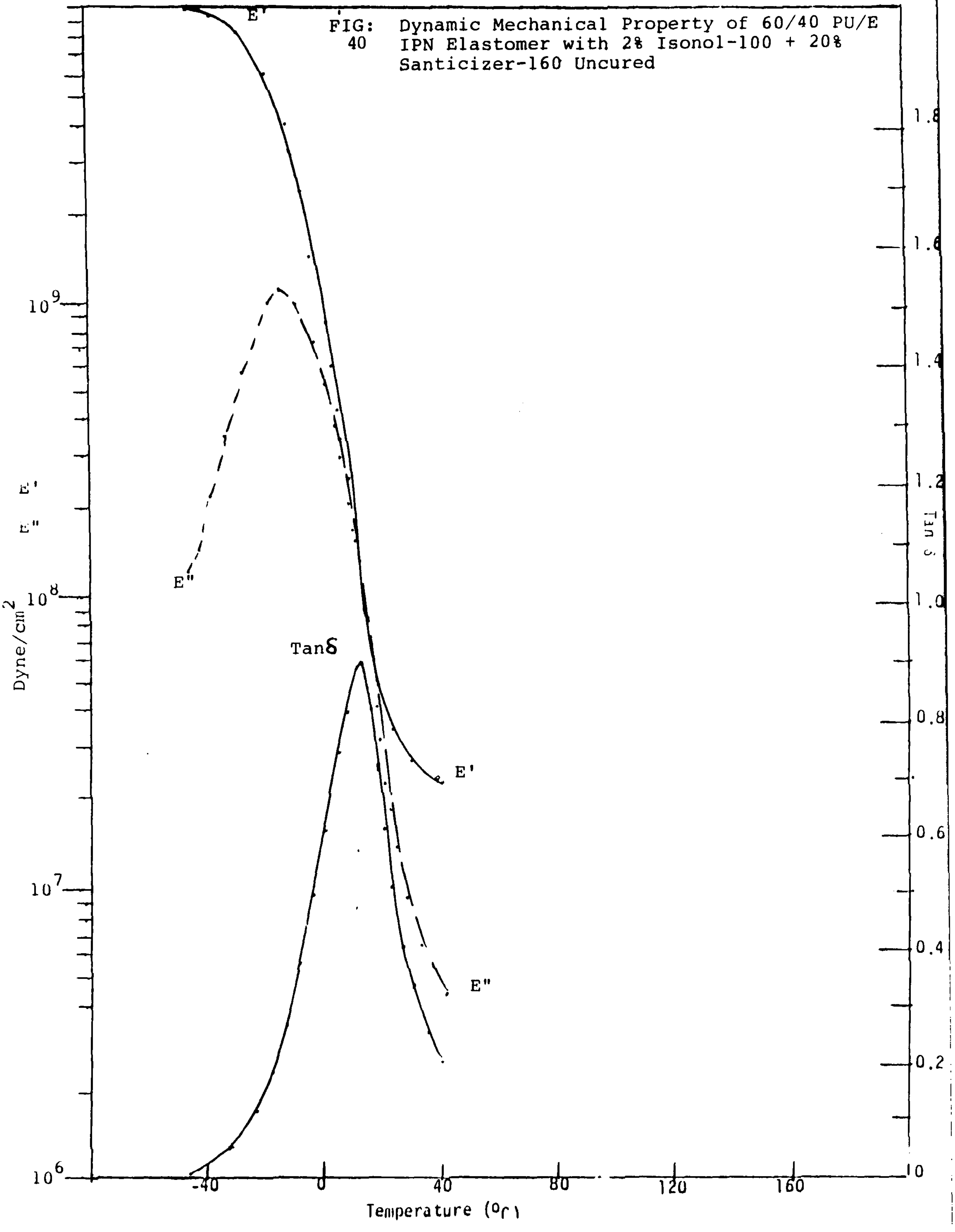


FIG: 40
Dynamic Mechanical Property of 60/40 PU/E IPN Elastomer with 2% Isonol-100 + 20% Santicizer-160 Uncured
E'
E"
Tanδ
E'
E"
Dyne/cm2
10^9
10^8
10^7
10^6
-40
0
40
80
120
160
Temperature (°C)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Tan δ

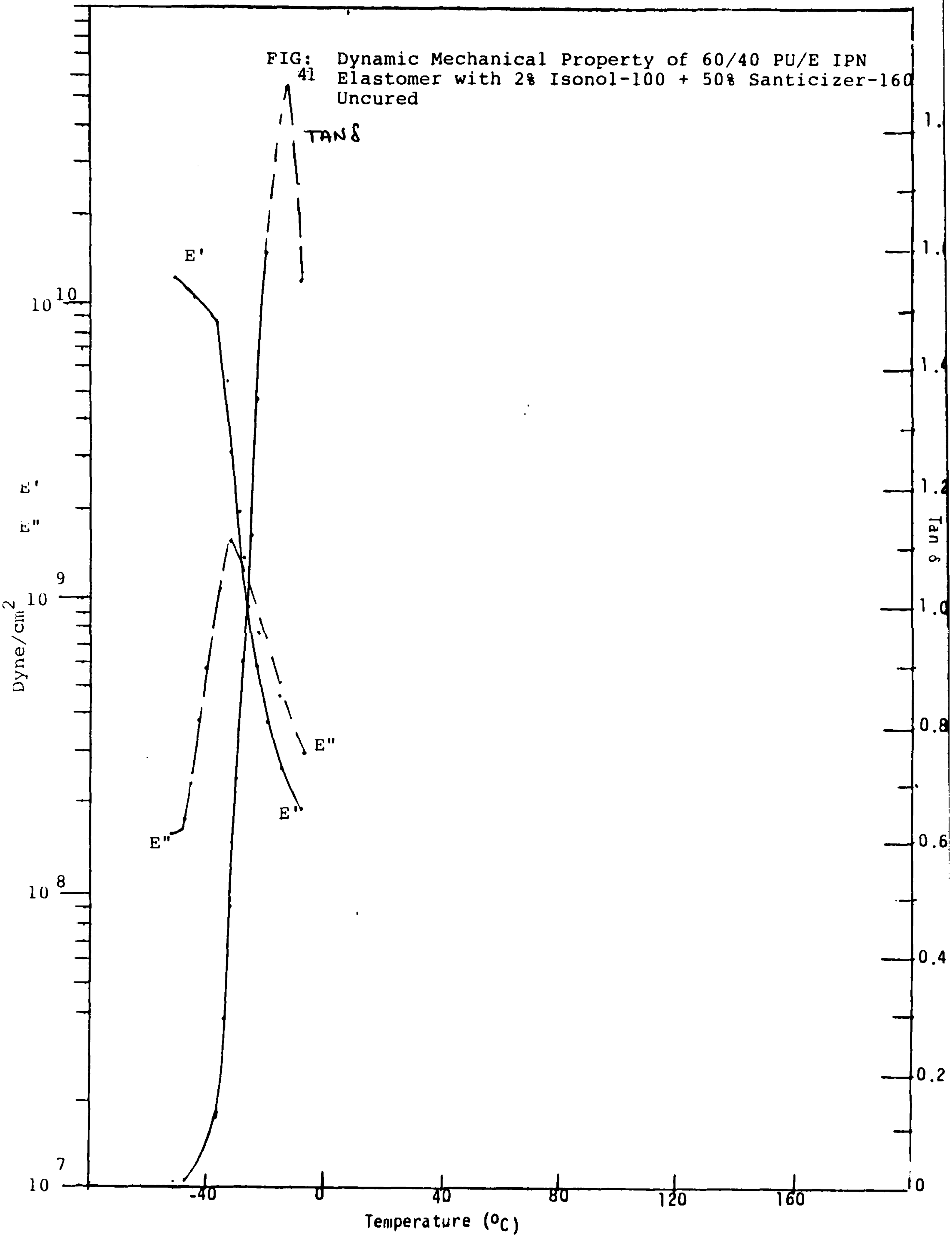
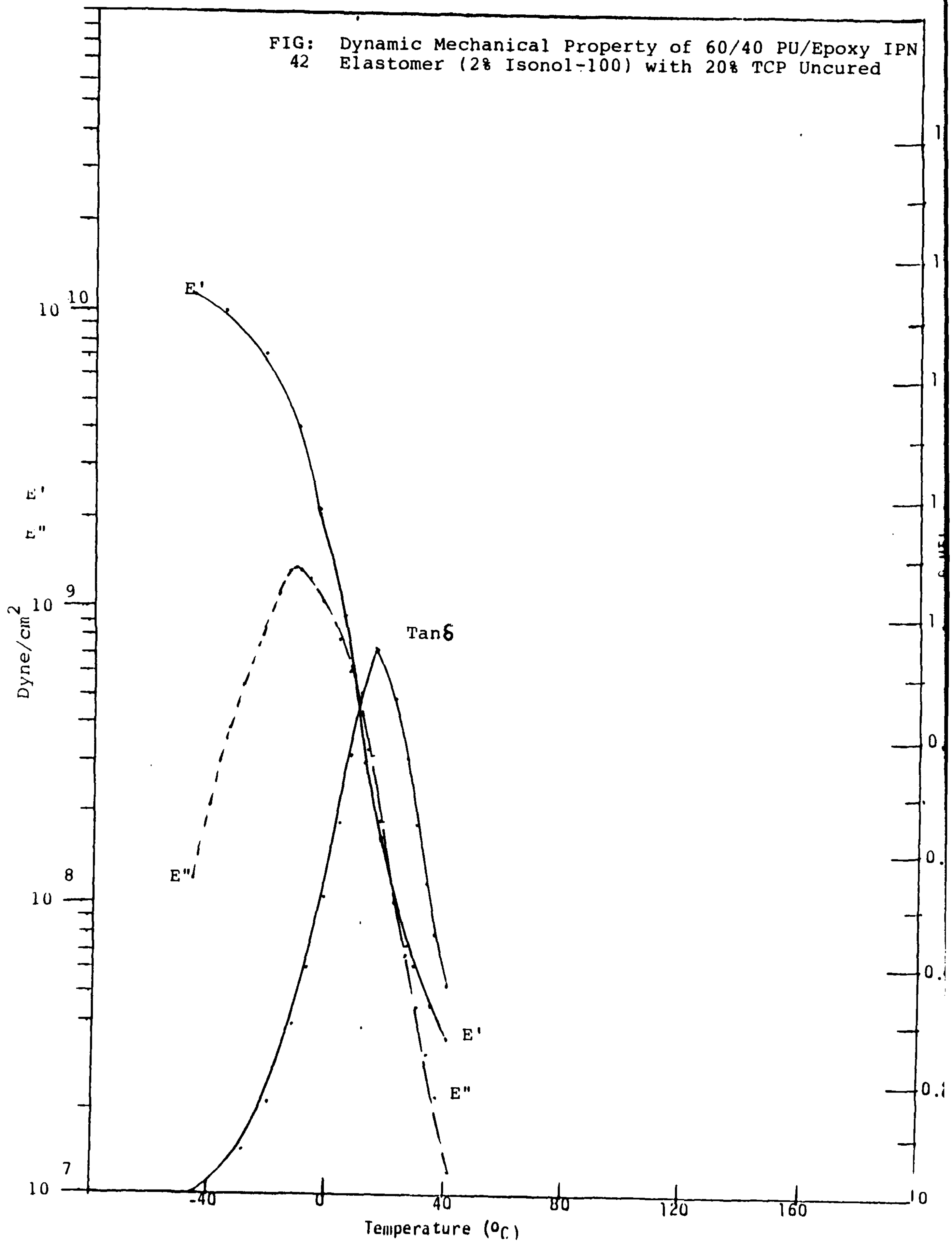


FIG: 41 Dynamic Mechanical Property of 60/40 PU/E IPN Elastomer with 2% Isonol-100 + 50% Santicizer-160 Uncured
TAN δ
E'
E"
Dyne/cm^2
10^{10}
10^9
10^8
10^7
Tan δ
-40
0
40
80
120
160
Temperature (^{o}C)

FIG: 42 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol-100) with 20% TCP Uncured



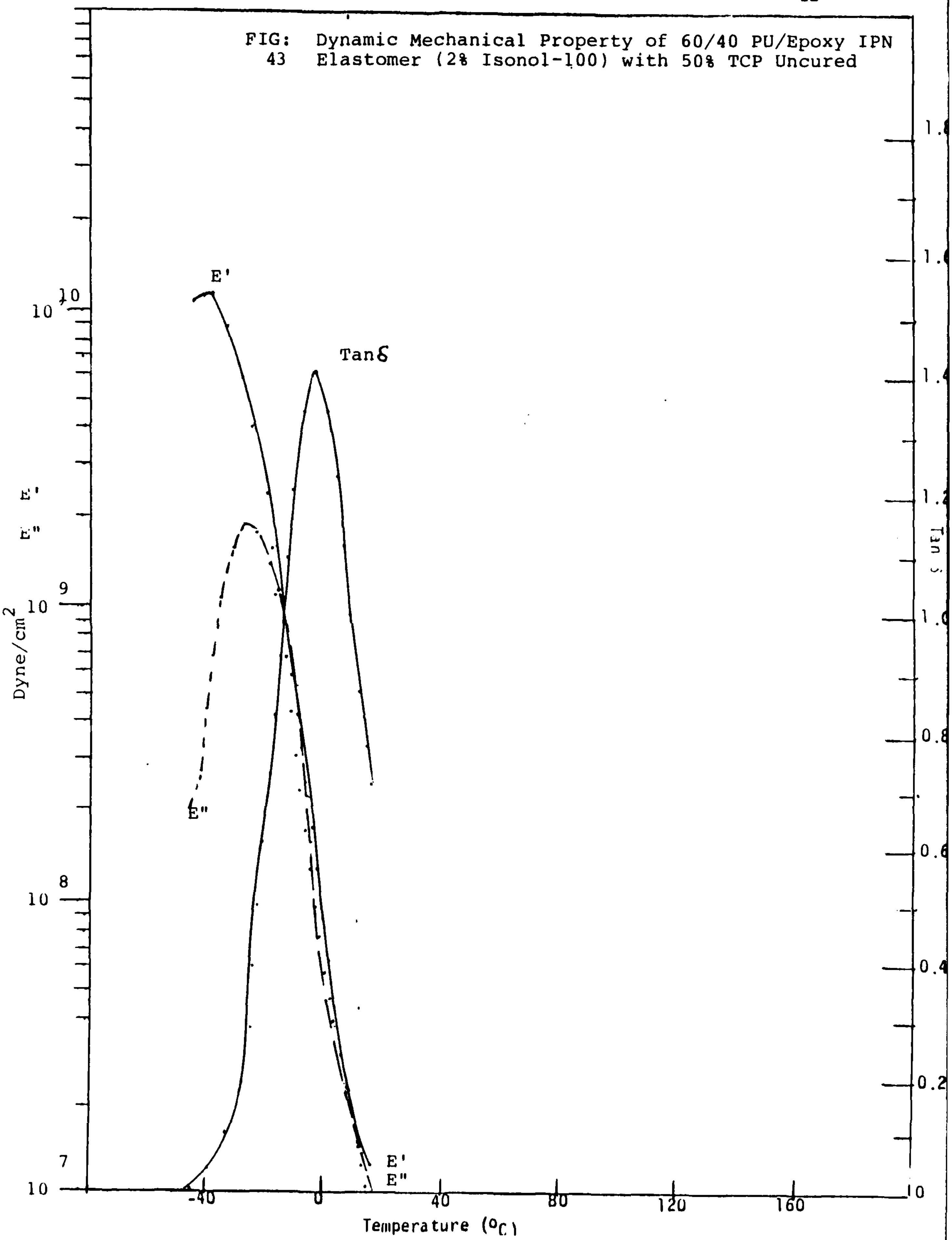
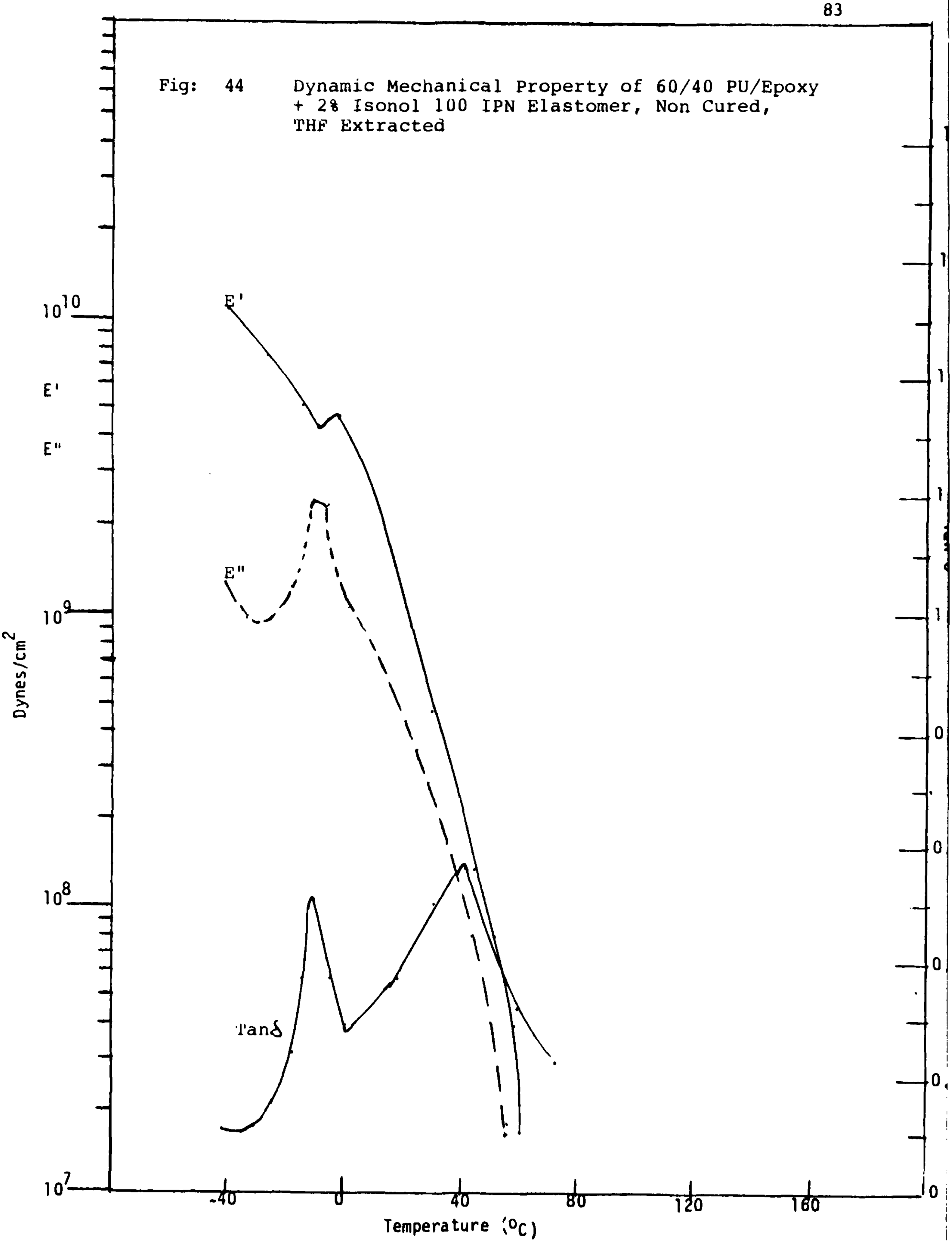


FIG: 43 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer (2% Isonol-100) with 50% TCP Uncured
E'
Tan δ
E"
E'
E"
E'
E"
10^{10}
10^{9}
10^{8}
10^{7}
Dyne/cm^2
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Tan δ
-40
0
40
80
120
160
Temperature (°C)

Fig: 44 Dynamic Mechanical Property of 60/40 PU/Epoxy + 2% Isonol 100 IPN Elastomer, Non Cured, THF Extracted



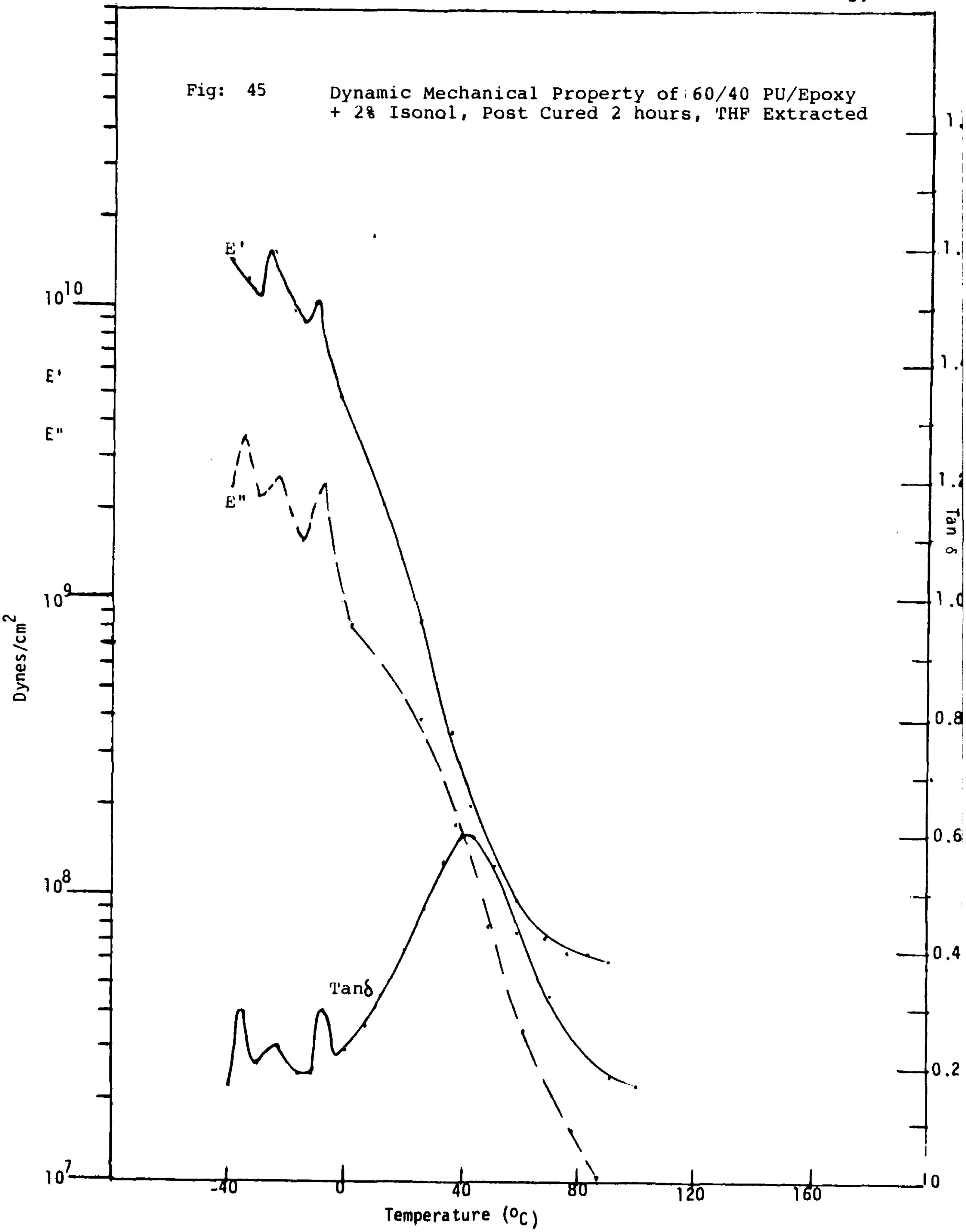


Fig: 45 Dynamic Mechanical Property of 60/40 PU/Epoxy + 2% Isonol, Post Cured 2 hours, THF Extracted

Fig: 46 Dynamic Mechanical Property of 60/40 PU/Epoxy IPN Elastomer, 4 hours Post cured, THF Extracted

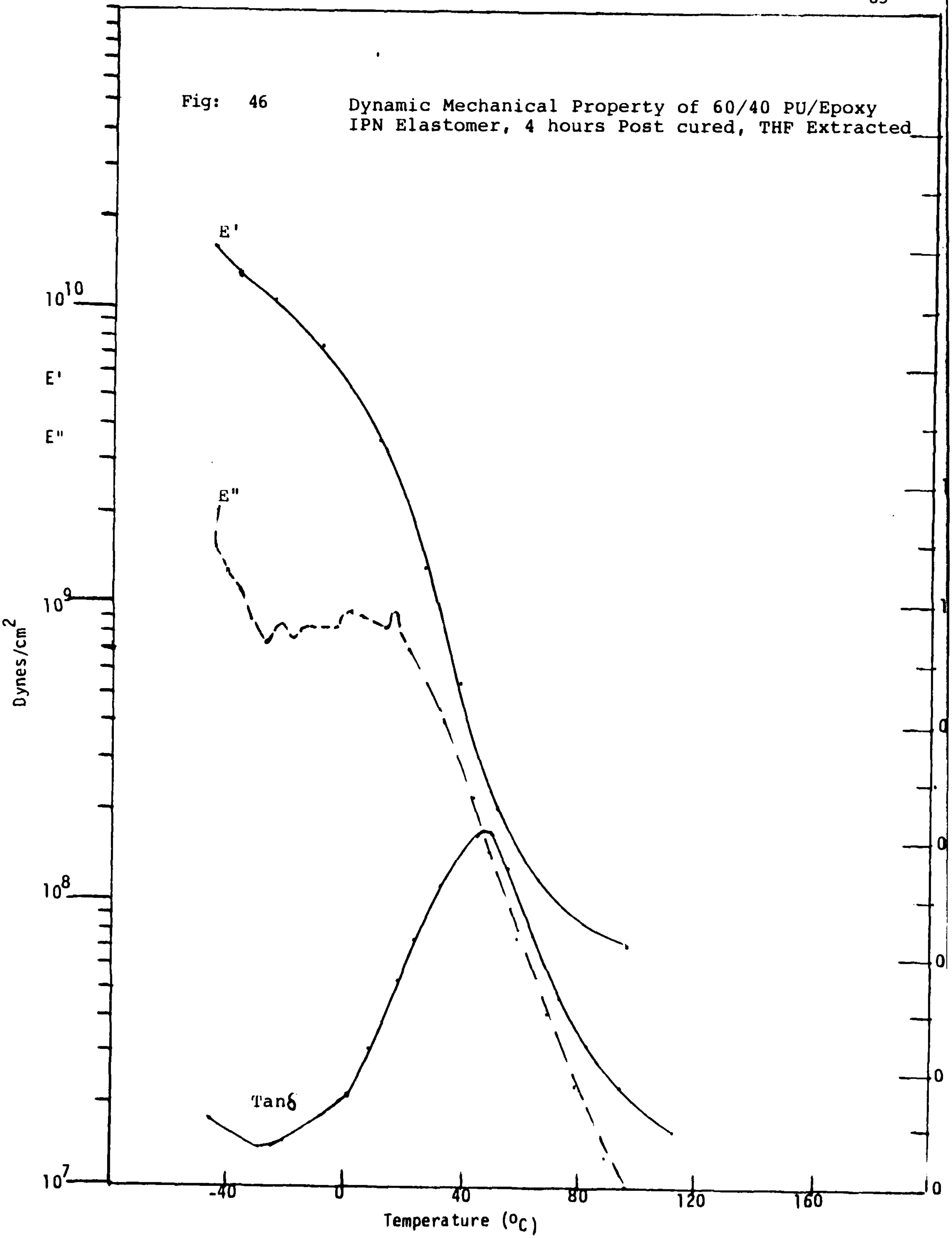
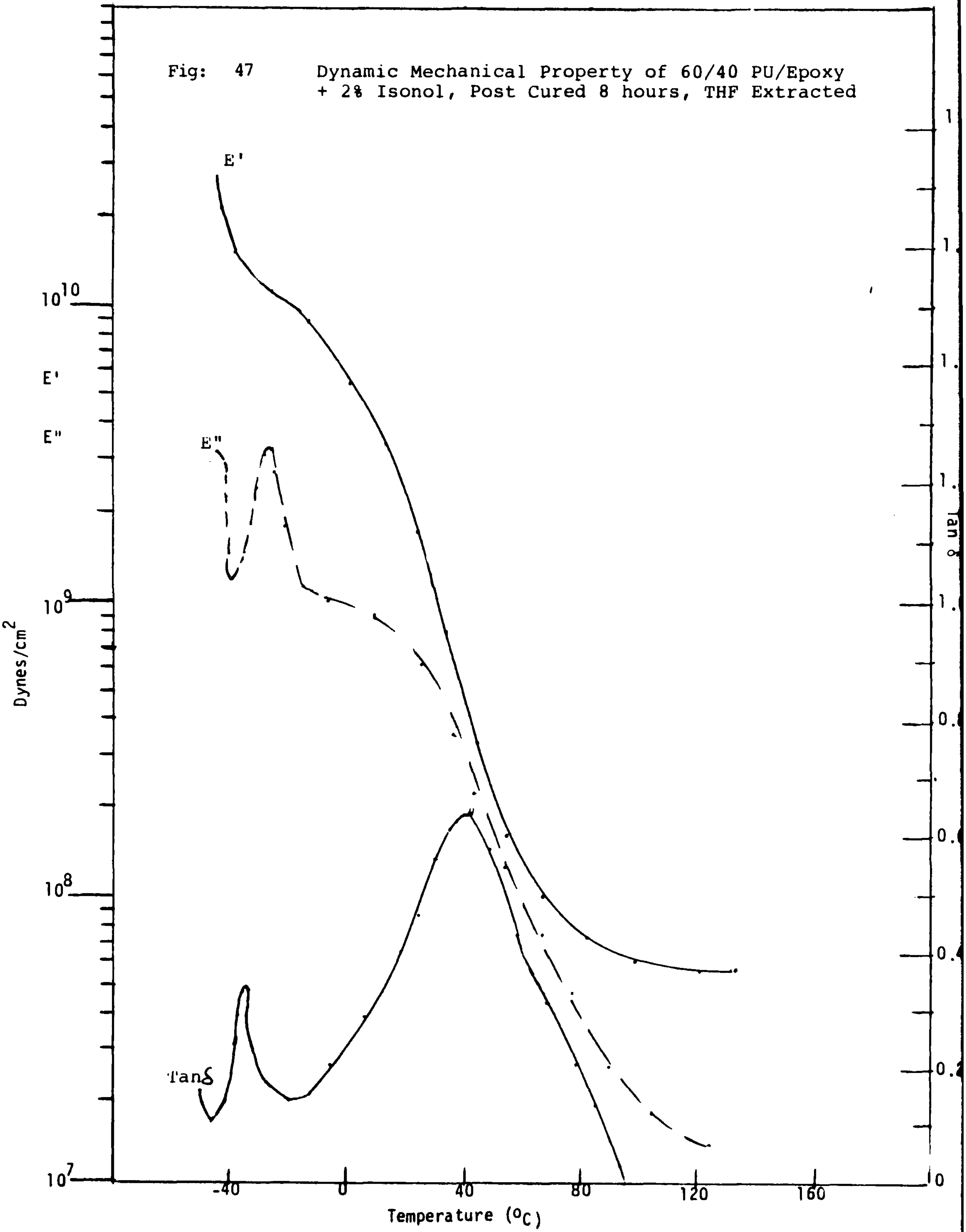


Fig: 47 Dynamic Mechanical Property of 60/40 PU/Epoxy + 2% Isonol, Post Cured 8 hours, THF Extracted



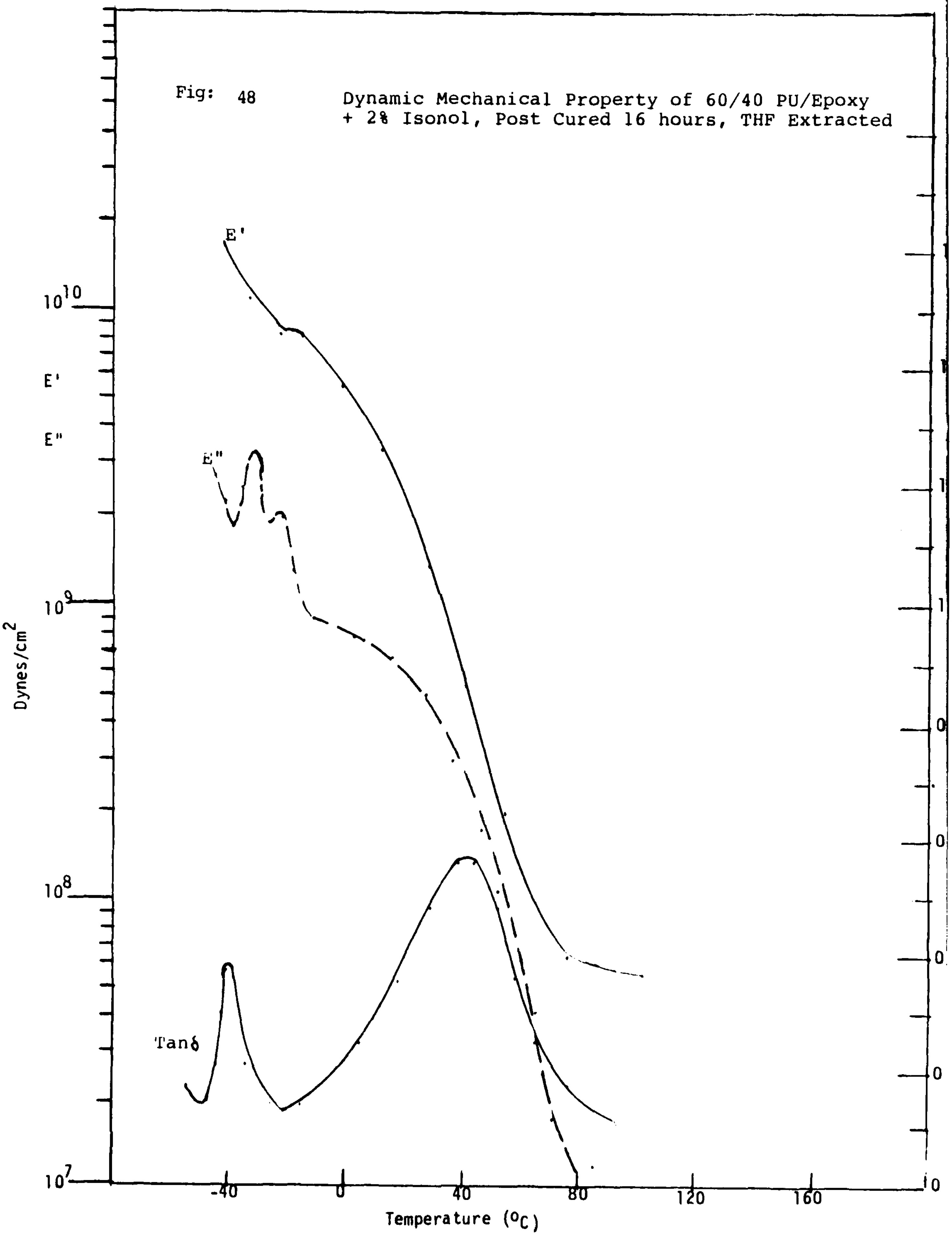


Fig: 48 Dynamic Mechanical Property of 60/40 PU/Epoxy + 2% Isonol, Post Cured 16 hours, THF Extracted
E'
E"
Tanδ
10^{10}
10^{9}
10^{8}
10^{7}
E'
E"
Dynes/cm^2
-40
0
40
80
120
160
Temperature (^oC)

Fig: 49 Comparision of the tan of THF extracted samples with different post-curing time.

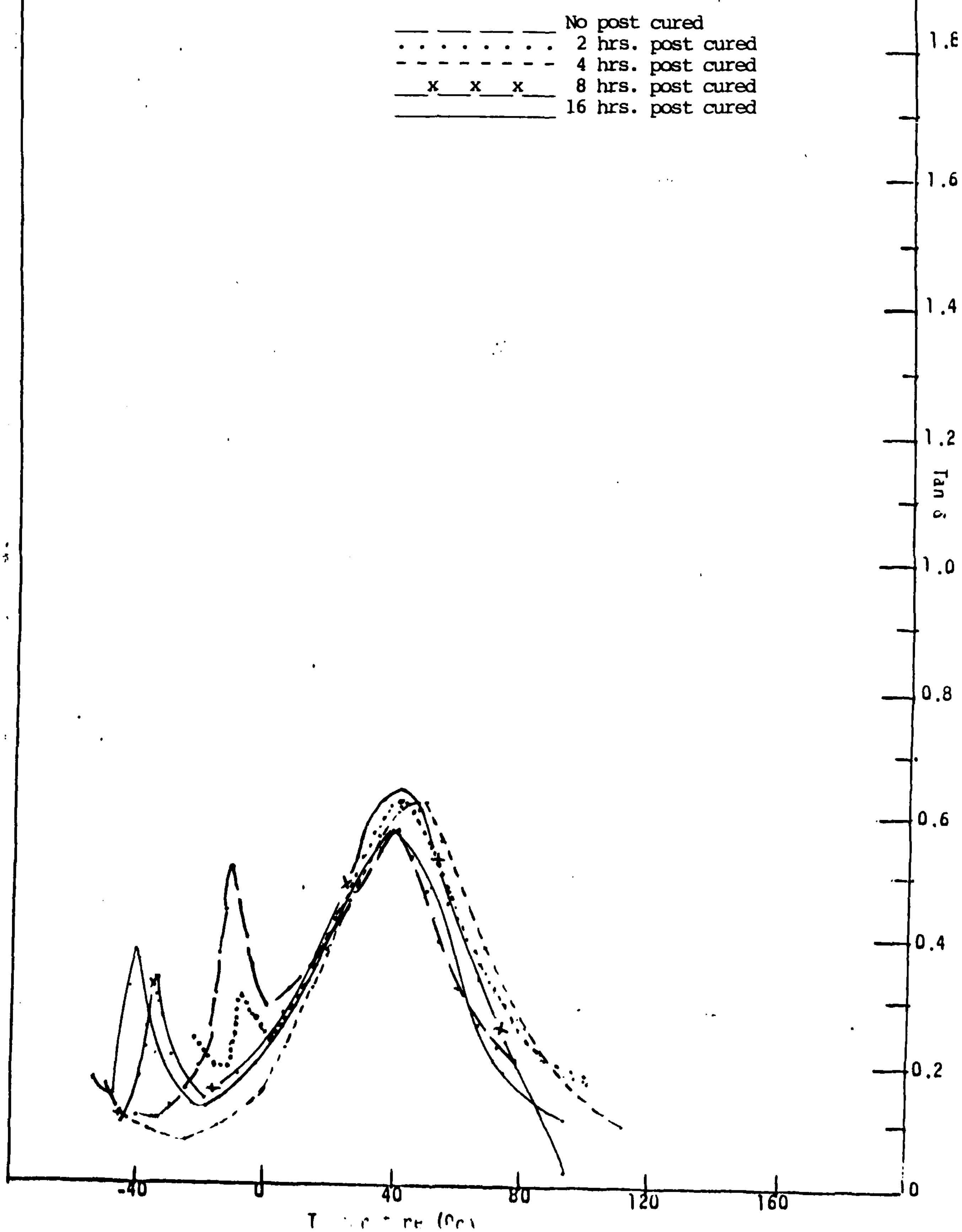
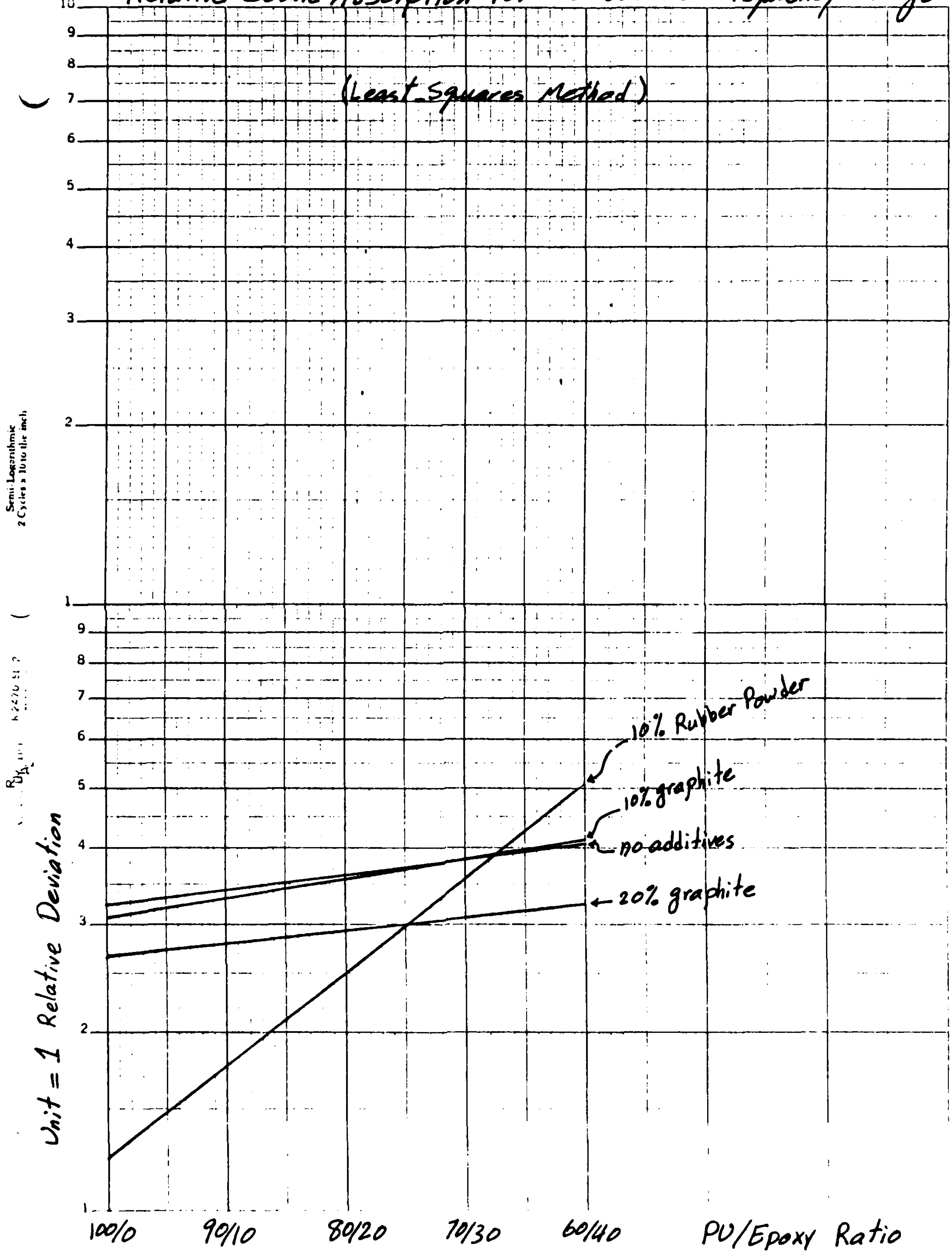


FIG. 50

Relative Sound Absorption For 0-500 Hz Frequency Range



Relative Sound Absorption For 0-500 Hz Frequency Range

FIG. 50A

(Raw Data)

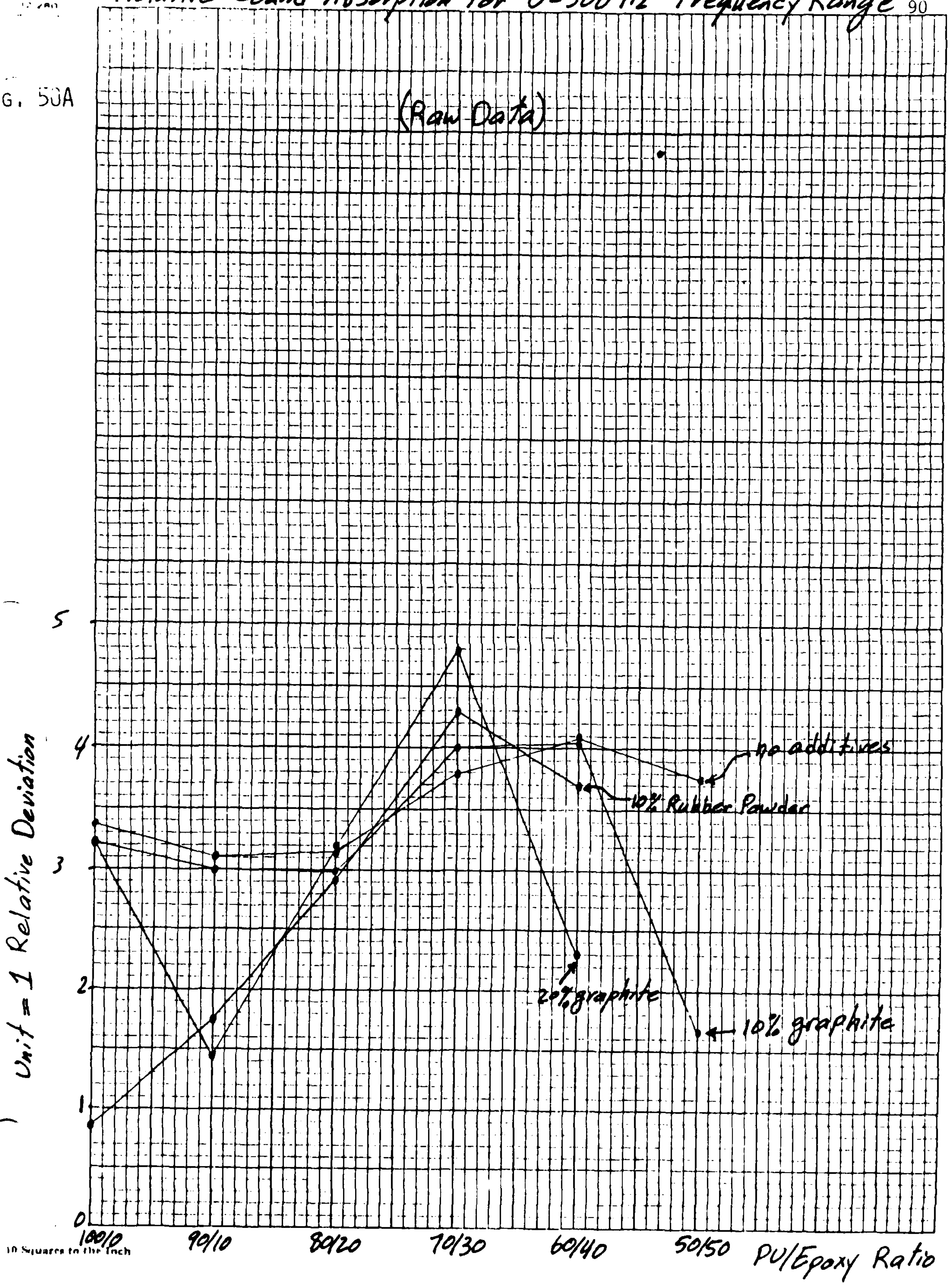
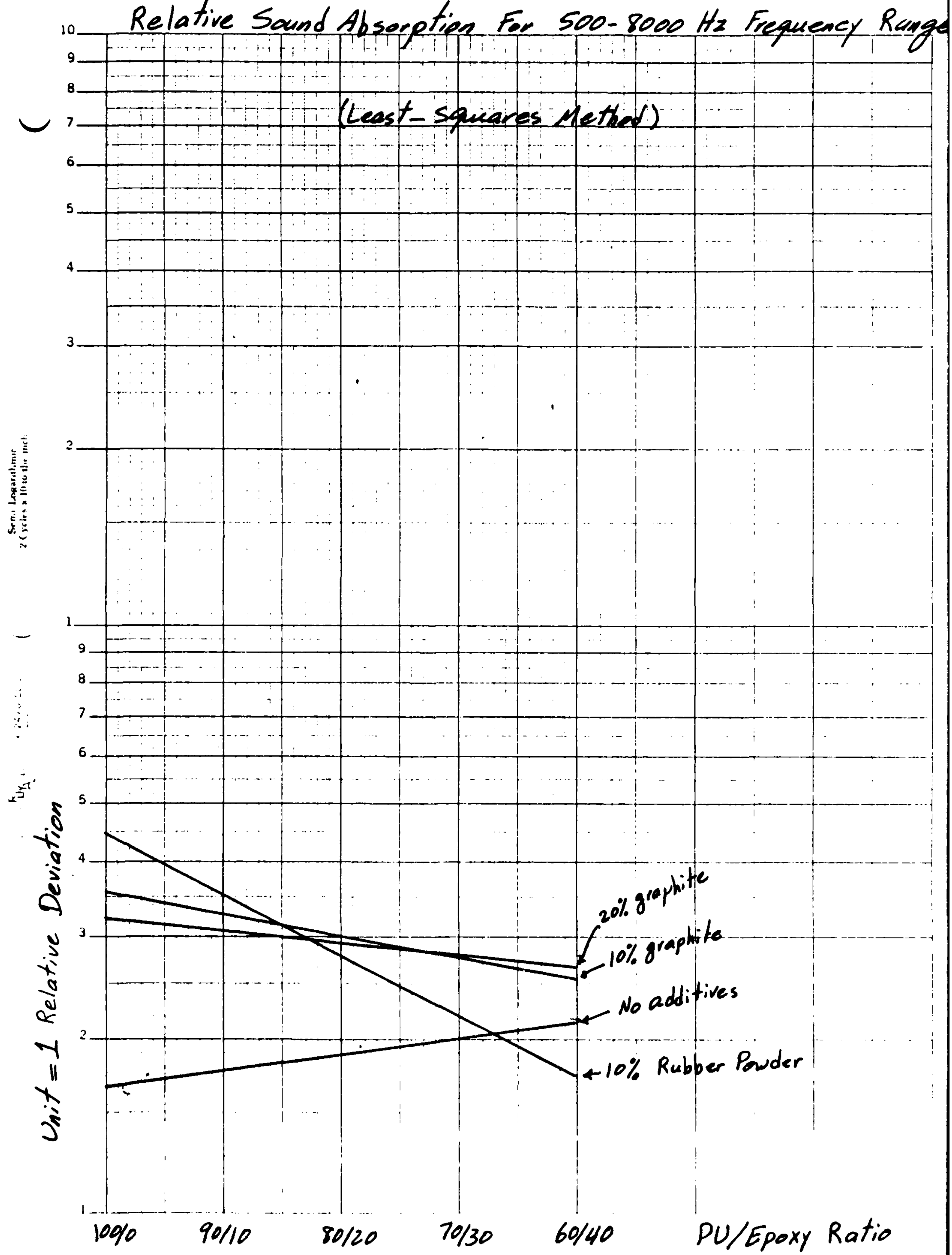
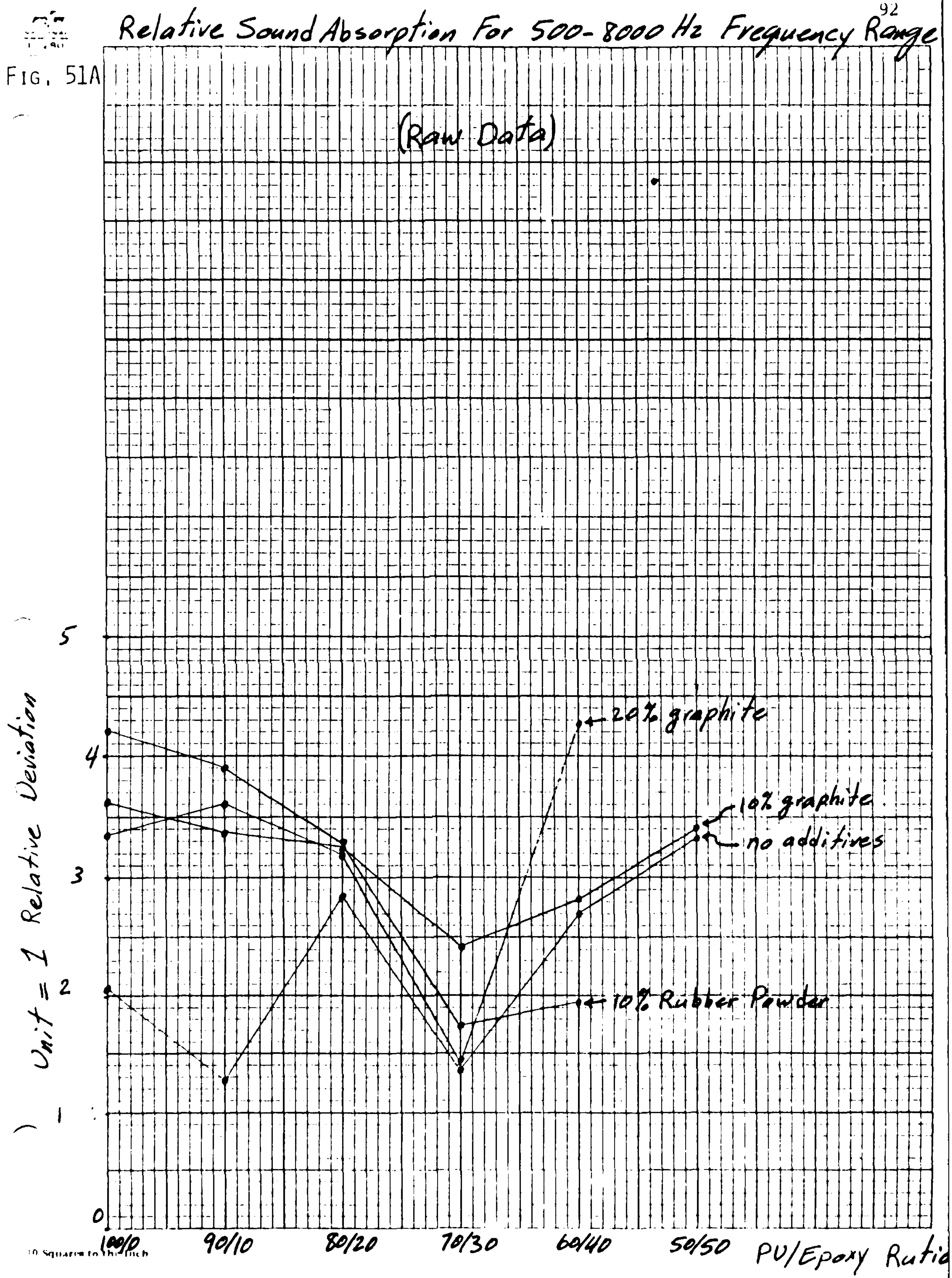


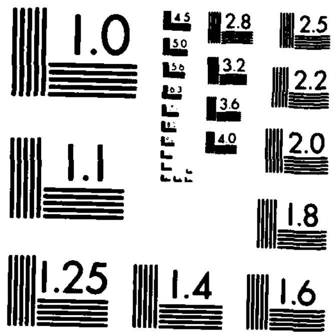
FIG. 51


Relative Sound Absorption For 500-8000 Hz Frequency Range
(Least-Squares Method)
Unit = 1 Relative Deviation
20% graphite
10% graphite
No additives
10% Rubber Powder
100/0
90/10
80/20
70/30
60/40
PU/Epoxy Ratio
10
9
8
7
6
5
4
3
2
1
9
8
7
6
5
4
3
2
1
Semi-Logarithmic
2 Cycles x 10 to the inch


Relative Sound Absorption For 500-8000 Hz Frequency Range
FIG. 51A
(Raw Data)
Unit = 1 Relative Deviation
0
1
2
3
4
5
20% graphite
10% graphite
no additives
10% Rubber Powder
100/0
90/10
80/20
70/30
60/40
50/50
PU/Epoxy Ratio
10 Squares to the Inch

AD-A172 901 ENERGY ABSORPTION OF POLYURETHANE BASED POLOYMER ALLOYS 2/2
(U) DETROIT UNIV MI POLYMER INST I RAZA ET AL
15 SEP 86 ARO-22361 2-MS DAAG25-85-K-0129

UNCLASSIFIED F/G 11/9 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FIG. 52
Relative Sound Absorption For 0-8000 Hz Frequency Range

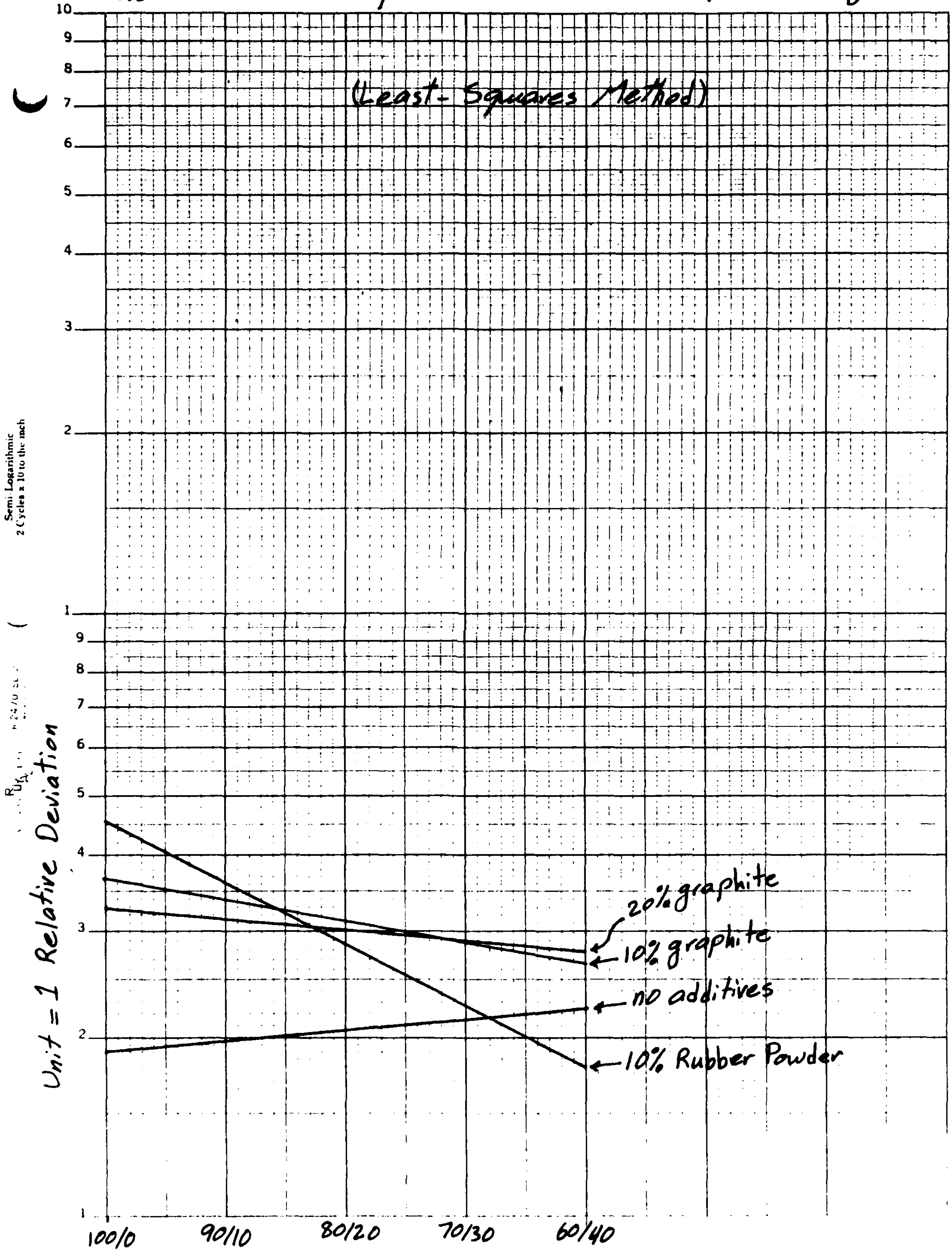


FIG. 52A Relative Sound Absorption For 0-8000 Hz Frequency Range

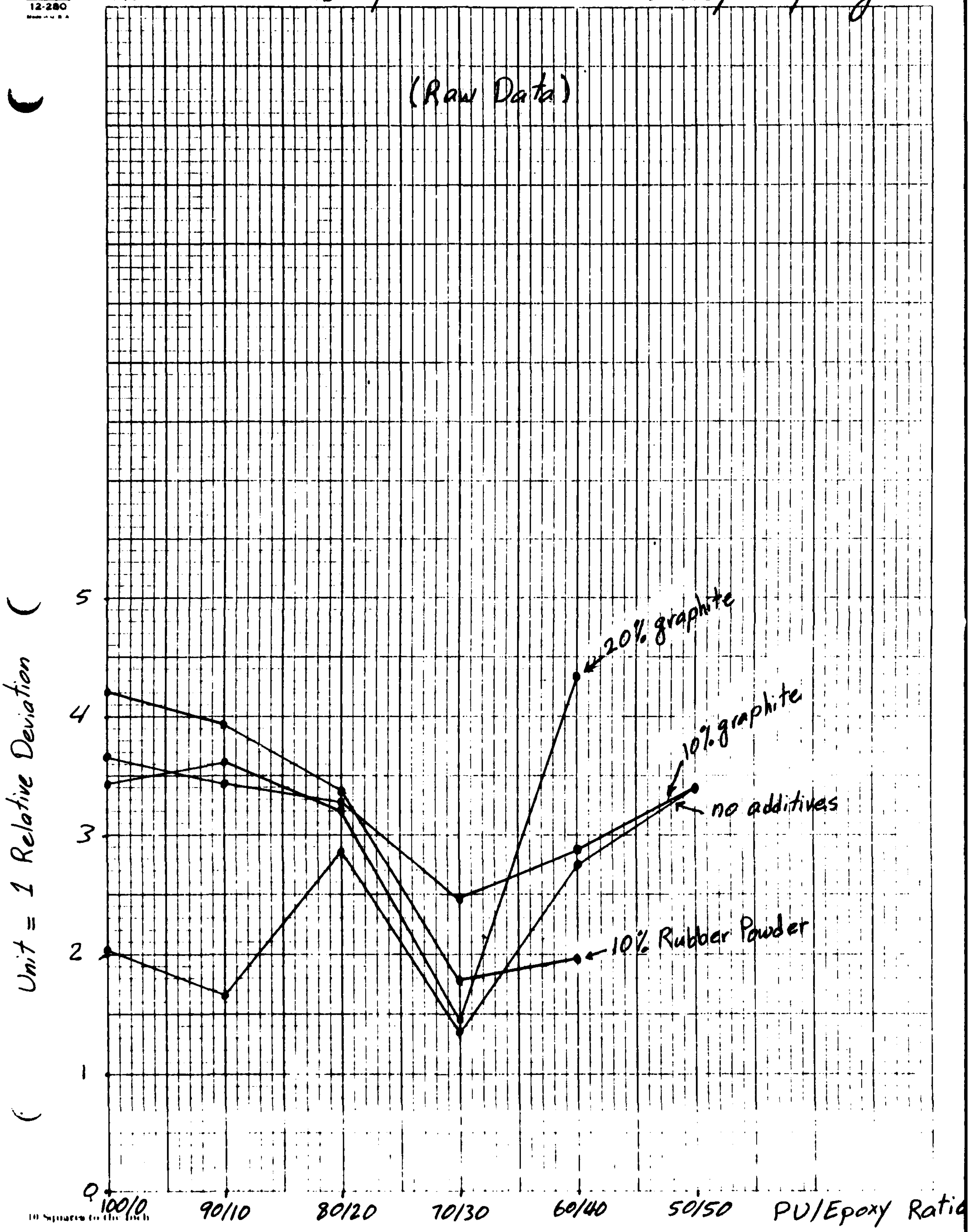


FIG 53

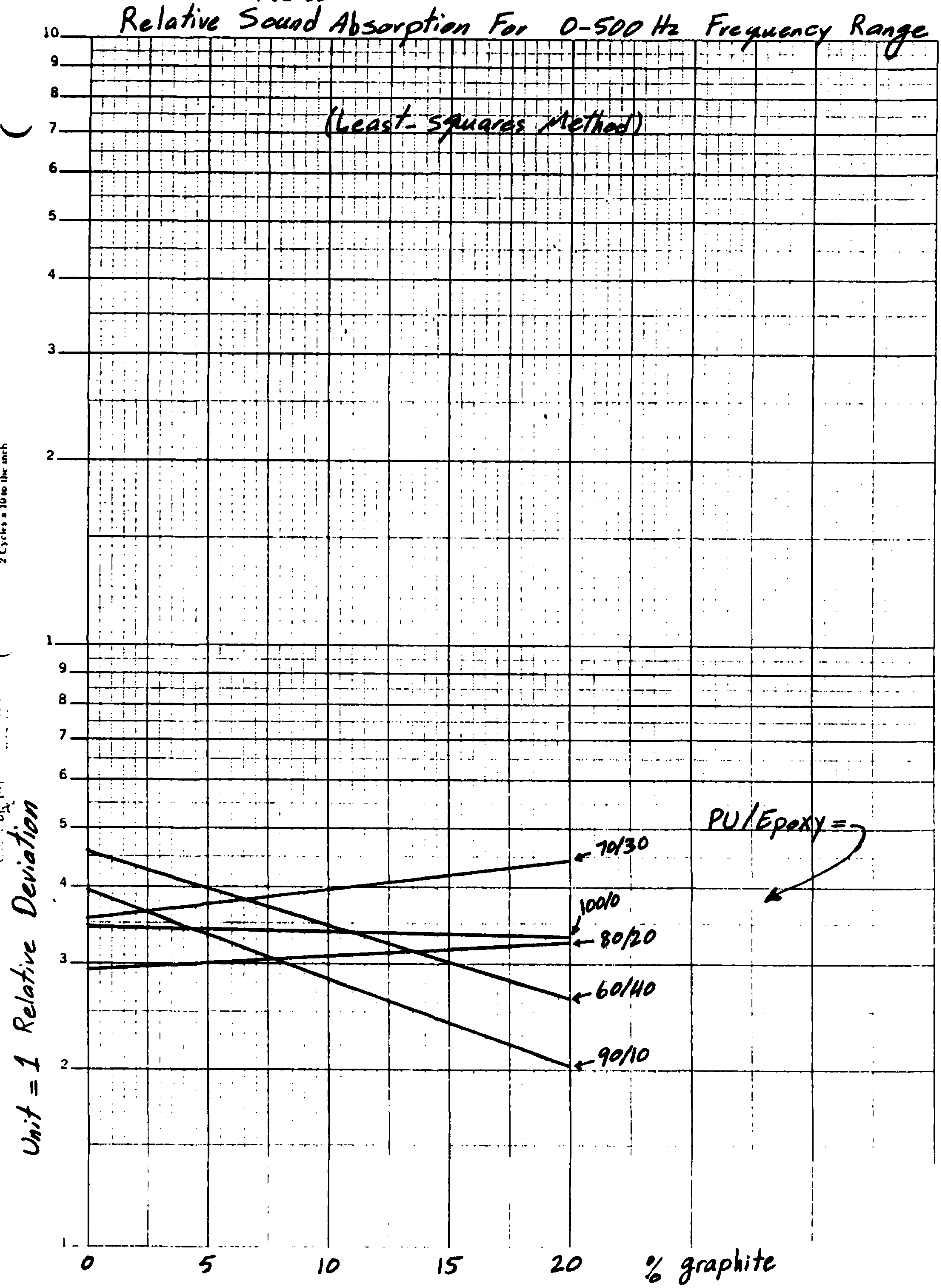

Relative Sound Absorption For 0-500 Hz Frequency Range
(Least-squares Method)
Unit = 1 Relative Deviation
% graphite
PU/Epoxy =
70/30
100/0
80/20
60/40
90/10
0
5
10
15
20
Semi Logarithmic
2 Cycles x 10 to the inch

FIG. 53A

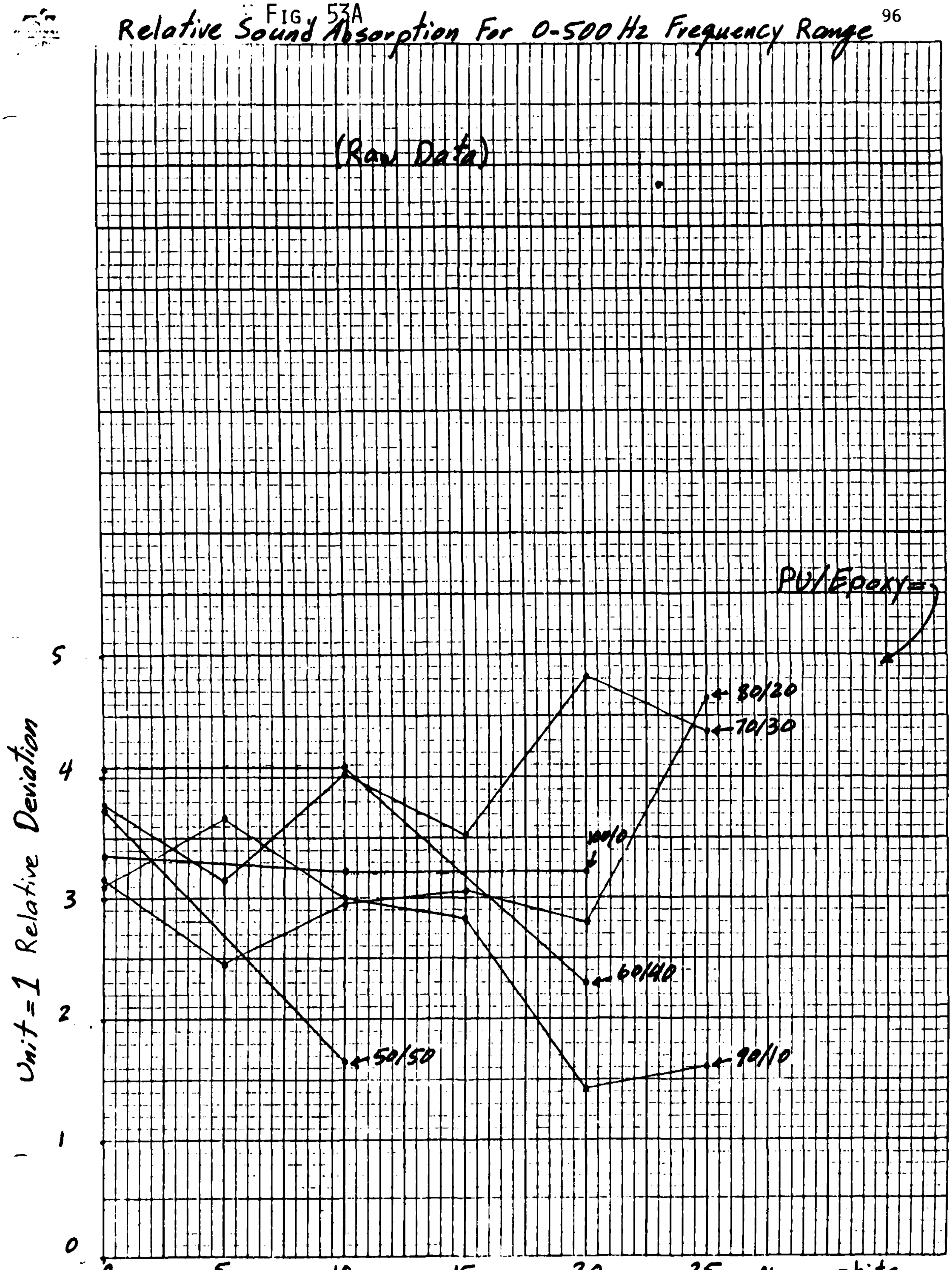

Relative Sound Absorption For 0-500 Hz Frequency Range
(Raw Data)
PU/Epoxy=
80/20
70/30
100/0
60/40
50/50
90/10
Unit=1 Relative Deviation
0
1
2
3
4
5
0
5
10
15
20
25
% graphite
10 Squares to the Inch

FIG. 54

Relative Sound Absorption For 500-8000 Hz Frequency Range

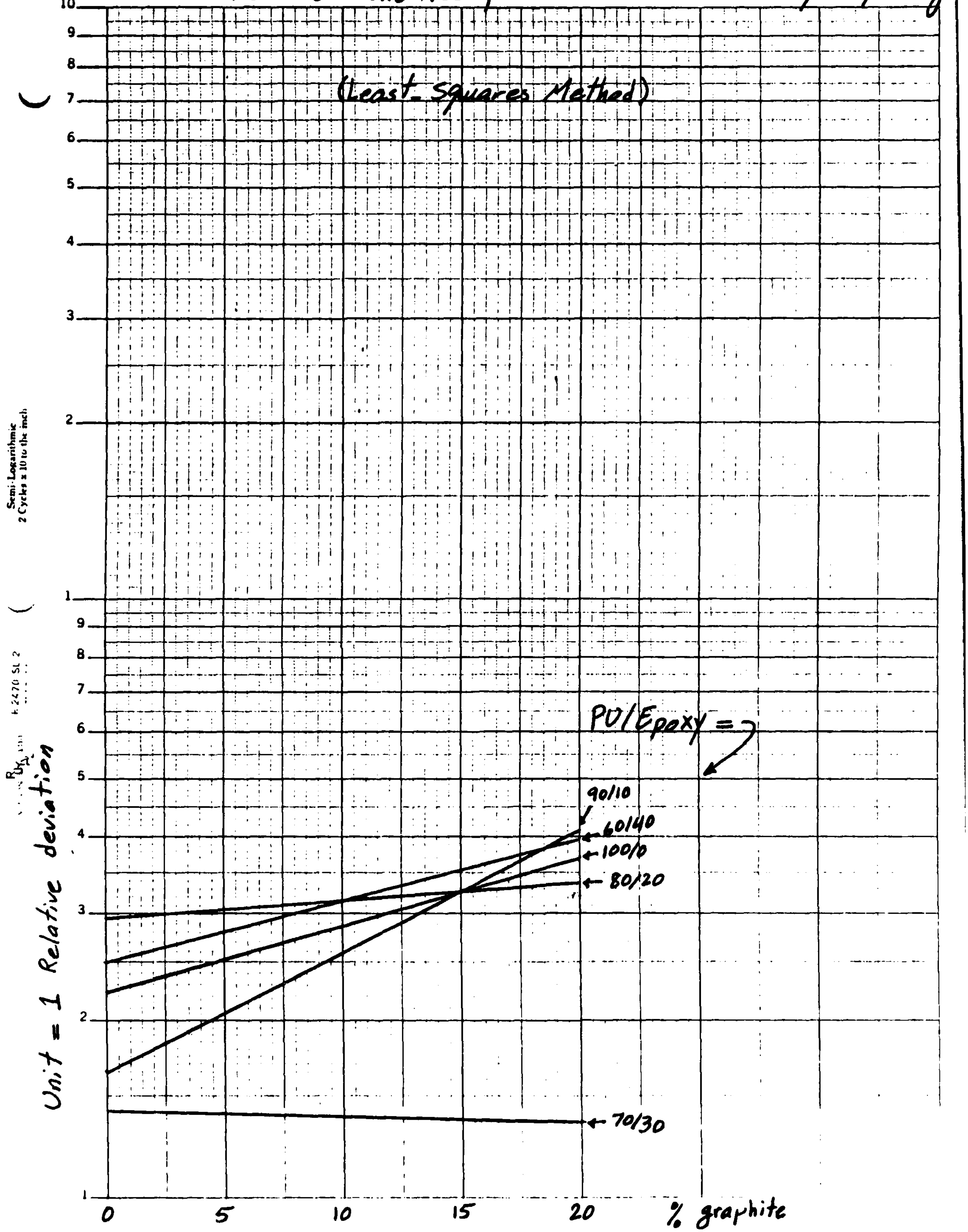


FIG. 54A

Relative Sound Absorption For 500-8000 Hz Frequency Range

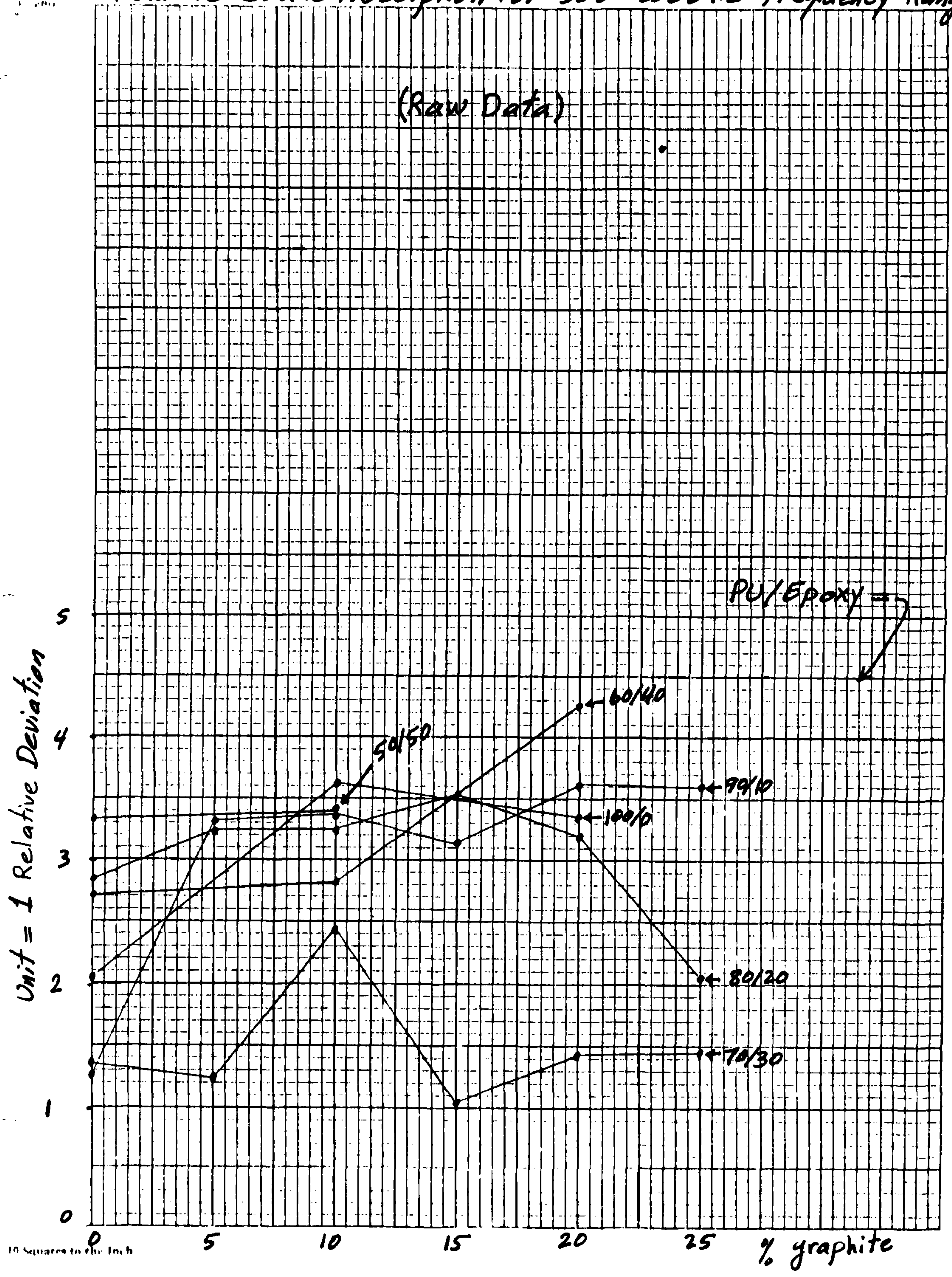


FIG. 55

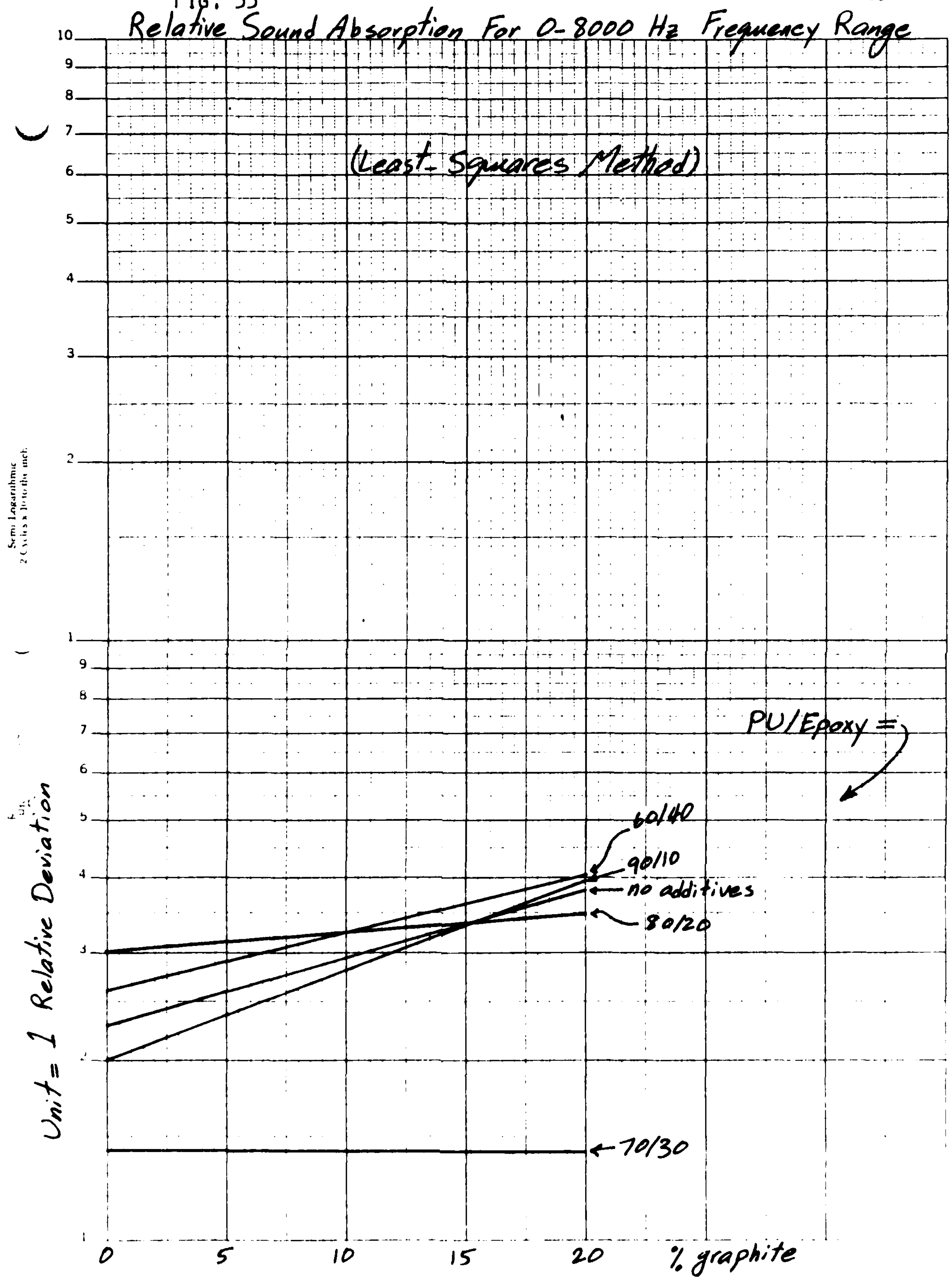

Relative Sound Absorption For 0-8000 Hz Frequency Range
(Least-Squares Method)
Unit = 1 Relative Deviation
% graphite
0
5
10
15
20
PU/Epoxy =
60/40
90/10
no additives
80/20
70/30
Semi Logarithmic
2 Cycles x 10 to the inch

FIG. 55A

Relative Sound Absorption For 0-8000 Hz Frequency Range

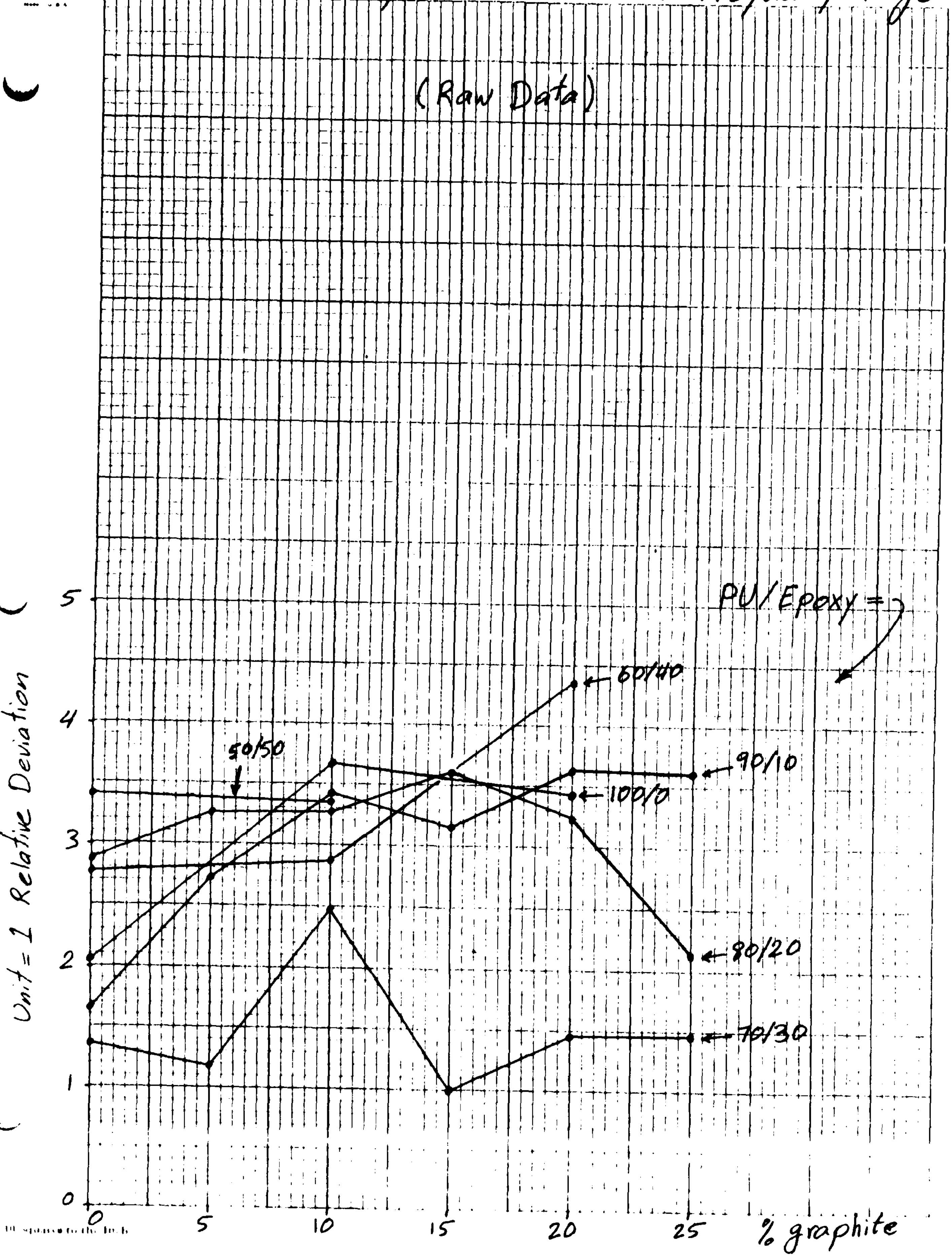


FIG. 56

Relative Sound Absorption For PU/Epoxy Ratio = 90/10 with Different Plasticizers, 20%

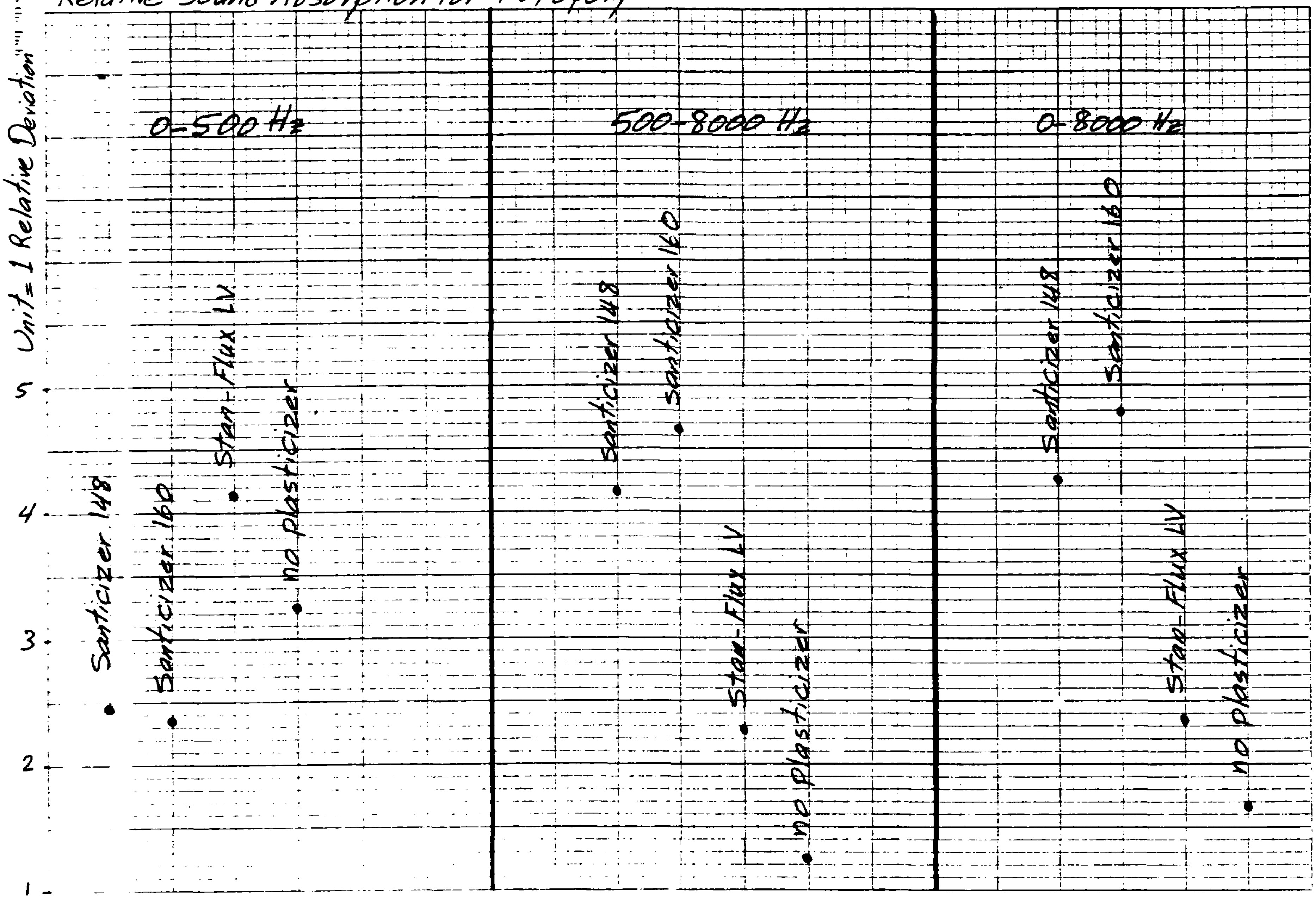


FIG. 57

Relative Sound Absorption For PU/Epoxy Ratio = 70/30 with Different Plasticizers, 20%

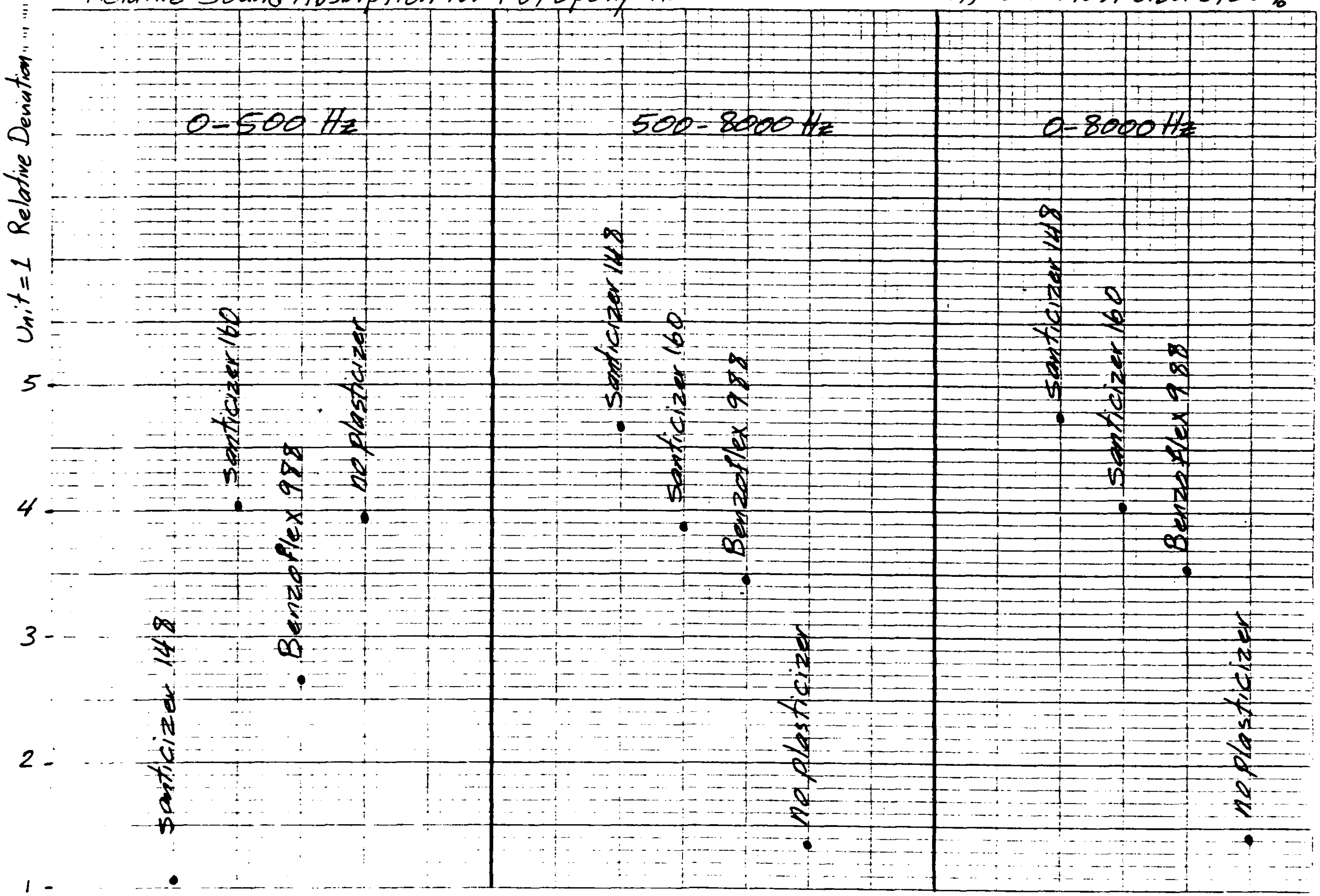


FIG. 53

50% Compression vs. % graphite

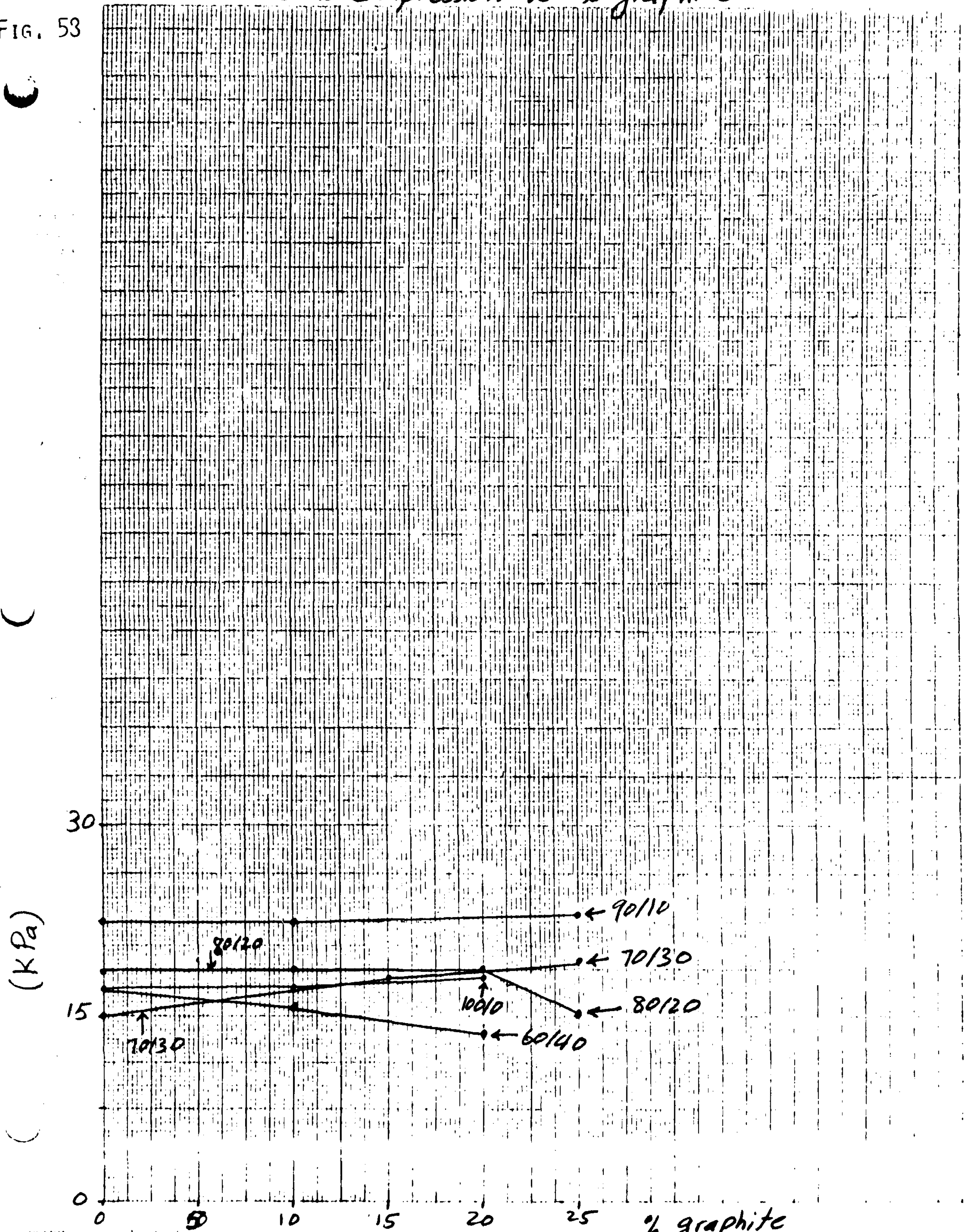


FIG. 59 Tensile Strength vs. % graphite

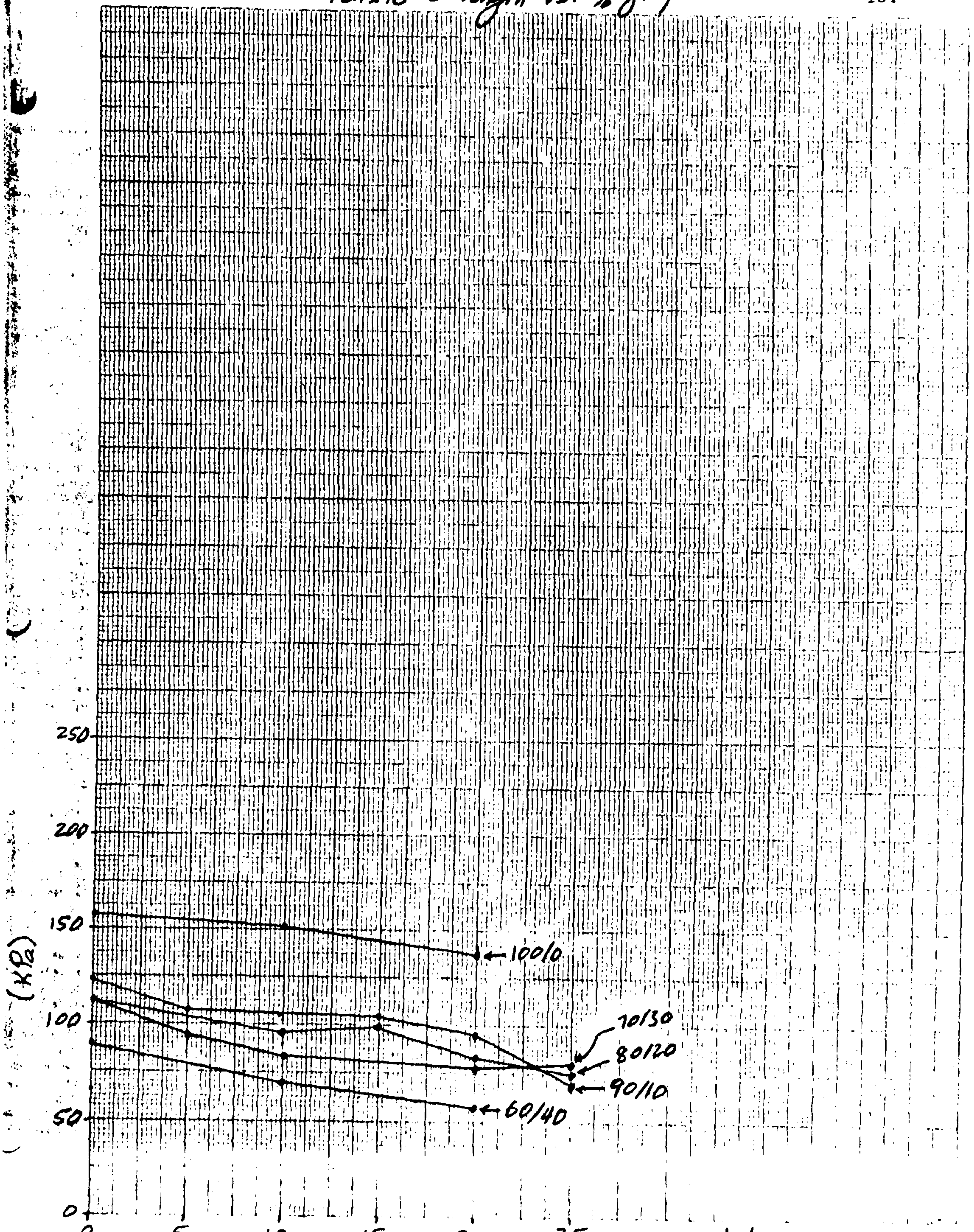


FIG. 60 Hysteresis vs. % graphite

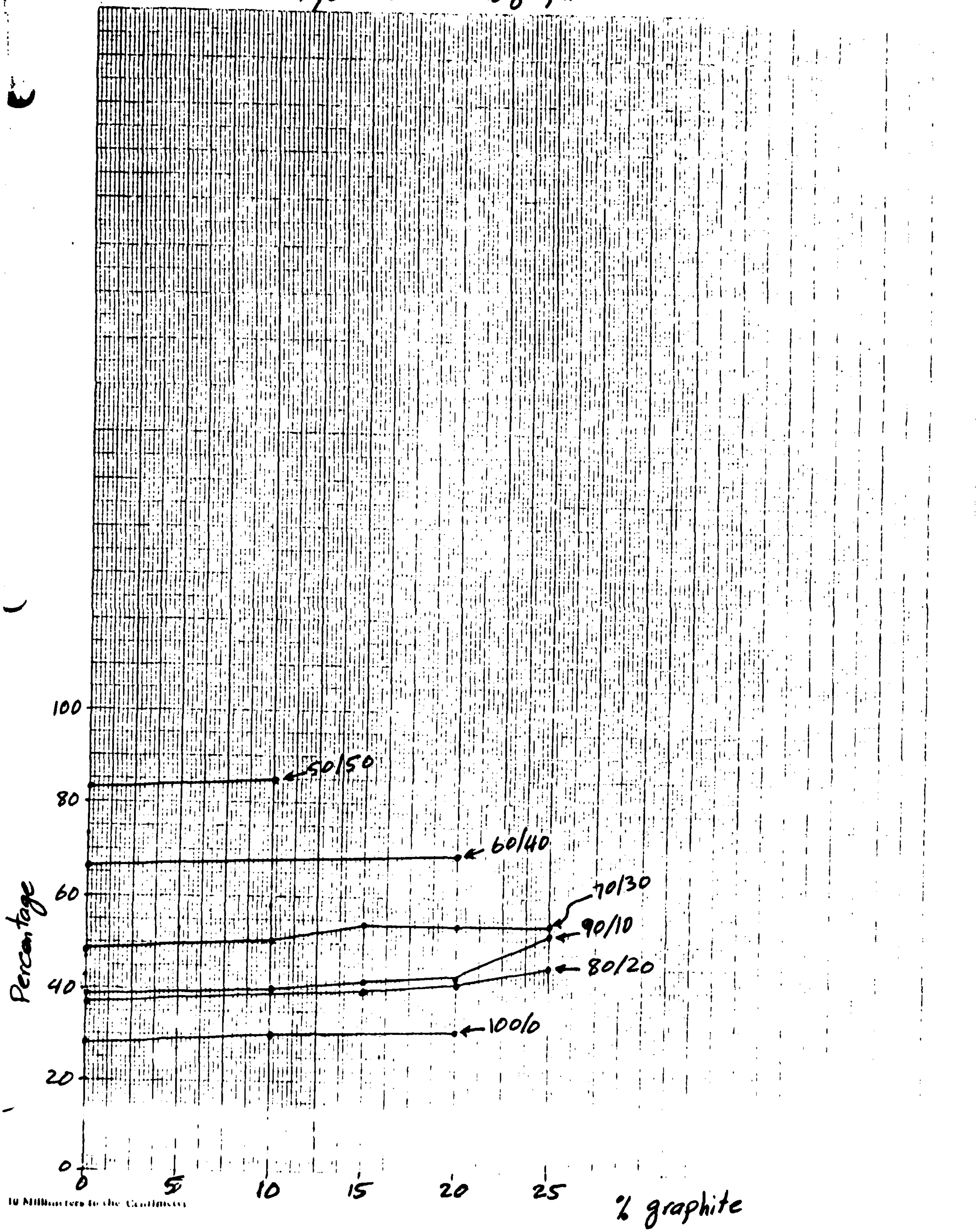


FIG. 61

50% Compression vs. PU/Epoxy Ratio

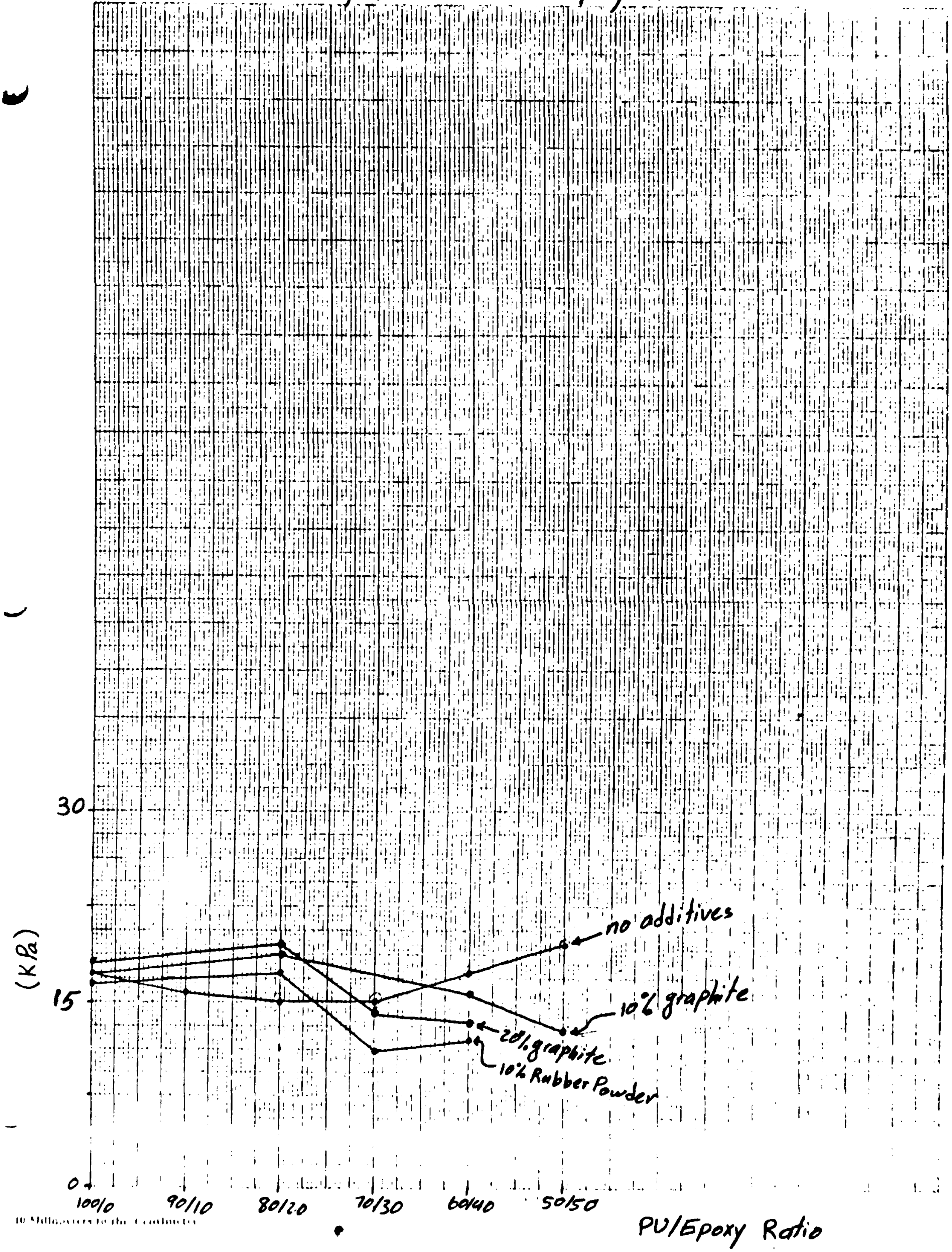


FIG. 62

Tensile Strength vs. PU/Epoxy Ratio

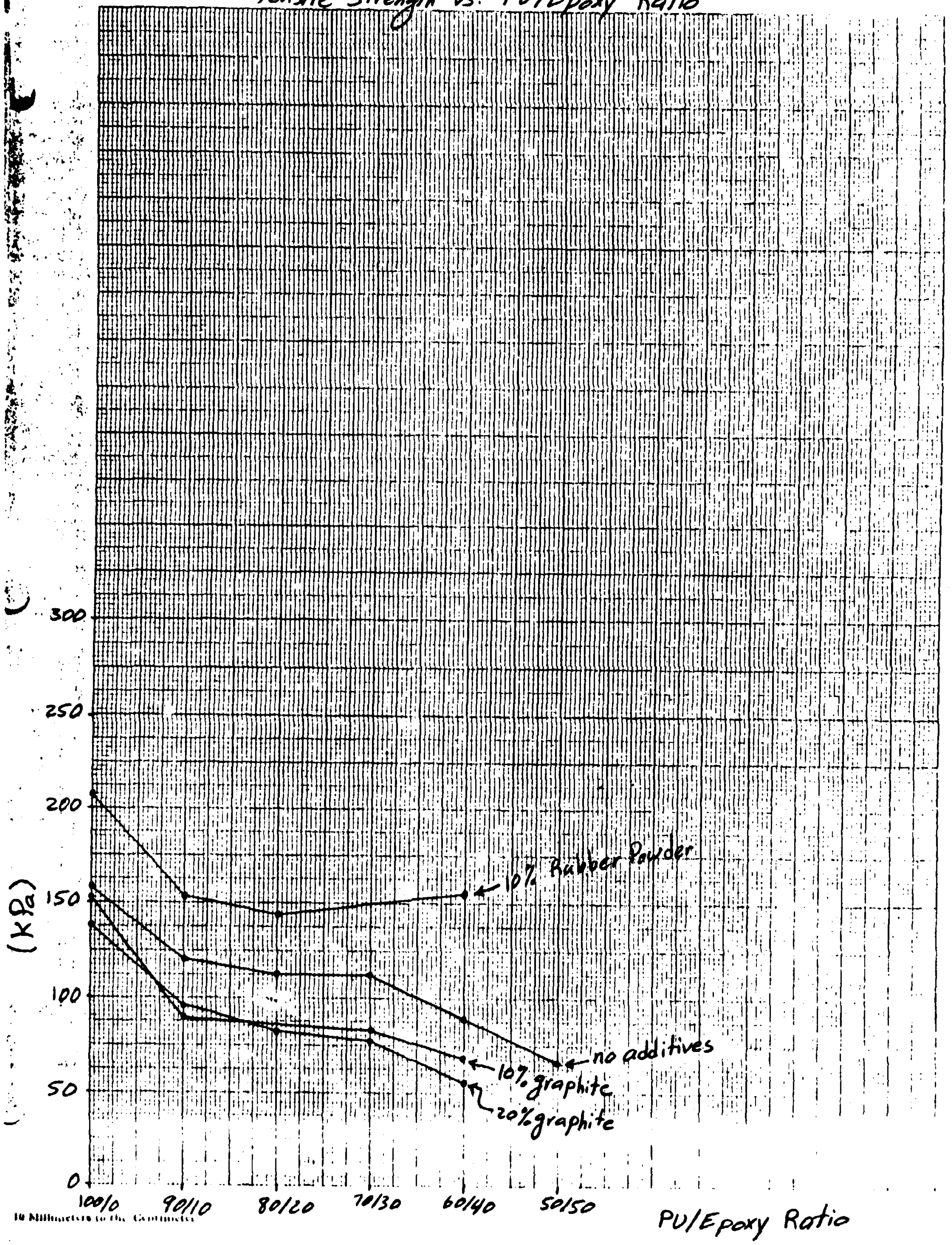
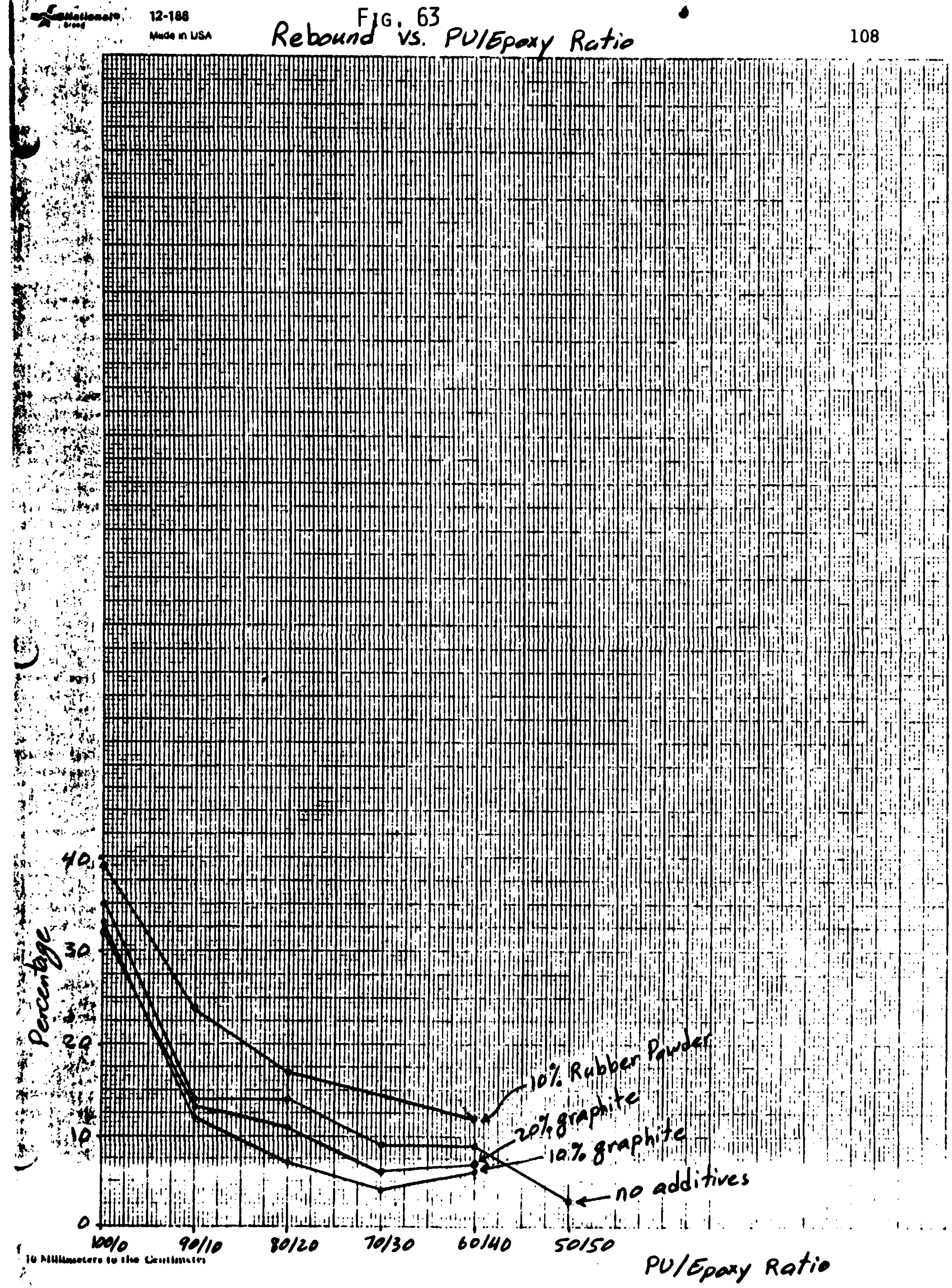


FIG. 63

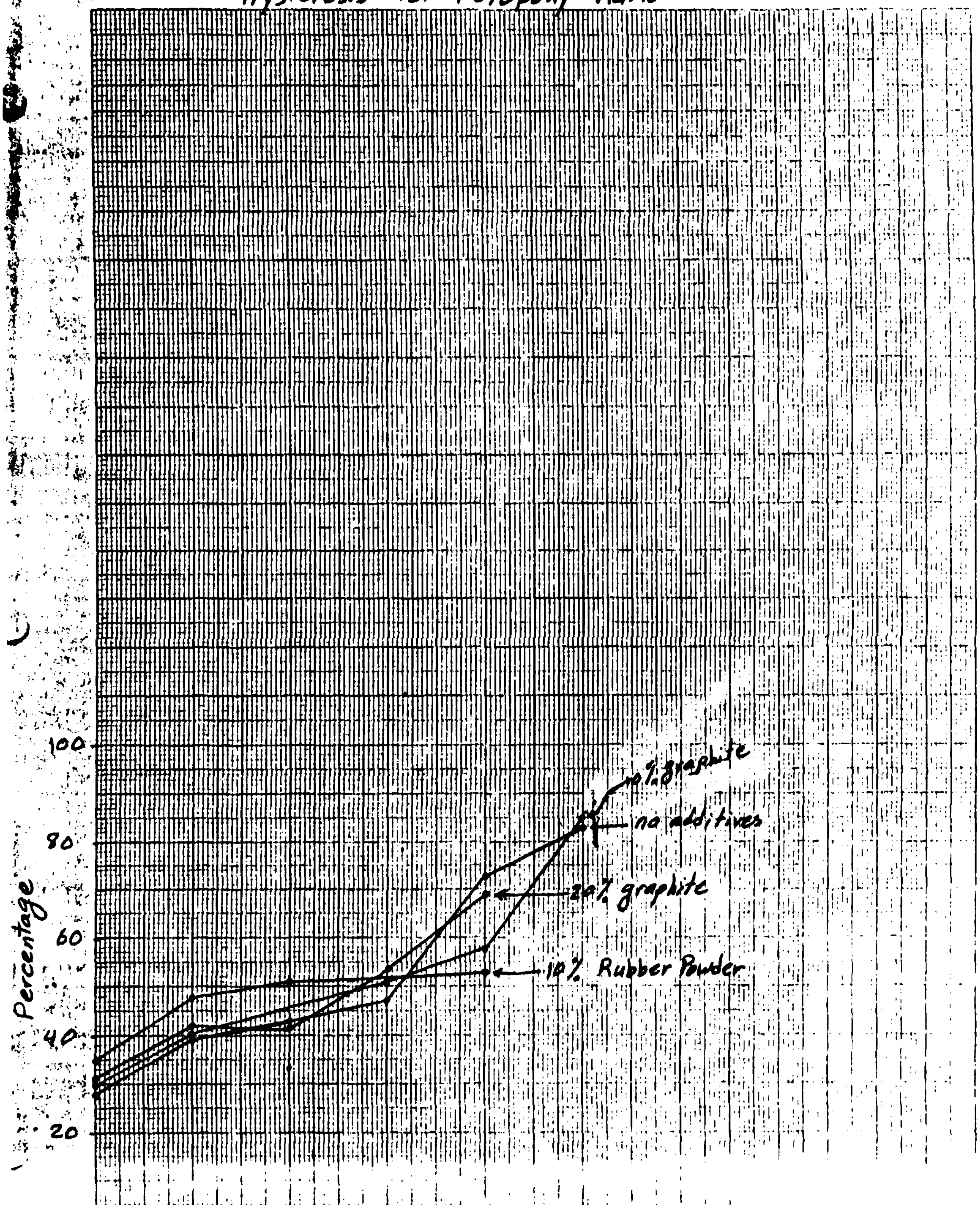
Rebound vs. PU/Epoxy Ratio



National 12-188 Made in USA

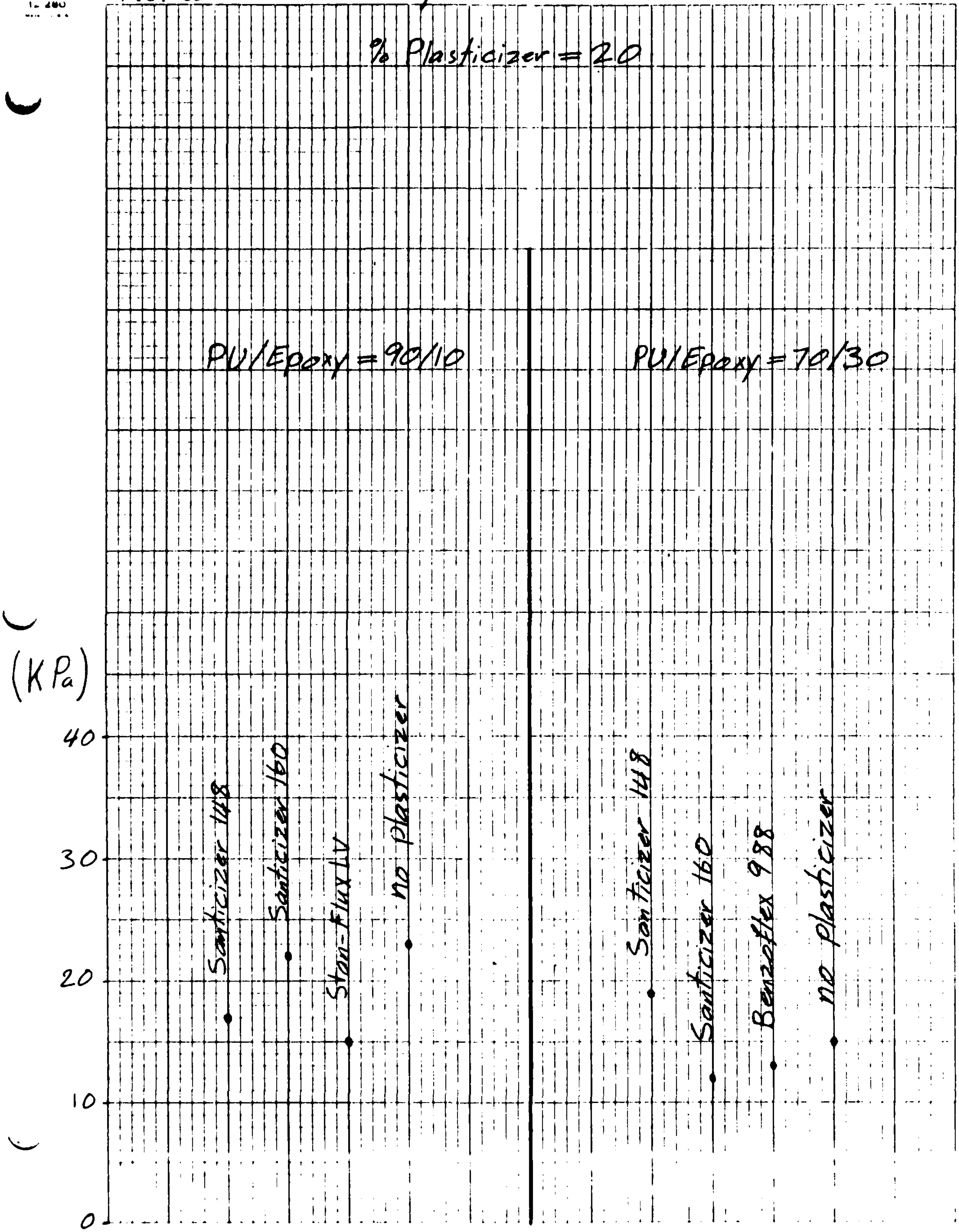
FIG. 64

Hysteresis vs. PU/Epoxy Ratio



10 Millimeters to the Centimeter

FIG. 65 50% Compression For Different Plasticizers



10 Squares to the Inch

FIG. 66 Hysteresis For Different Plasticizers

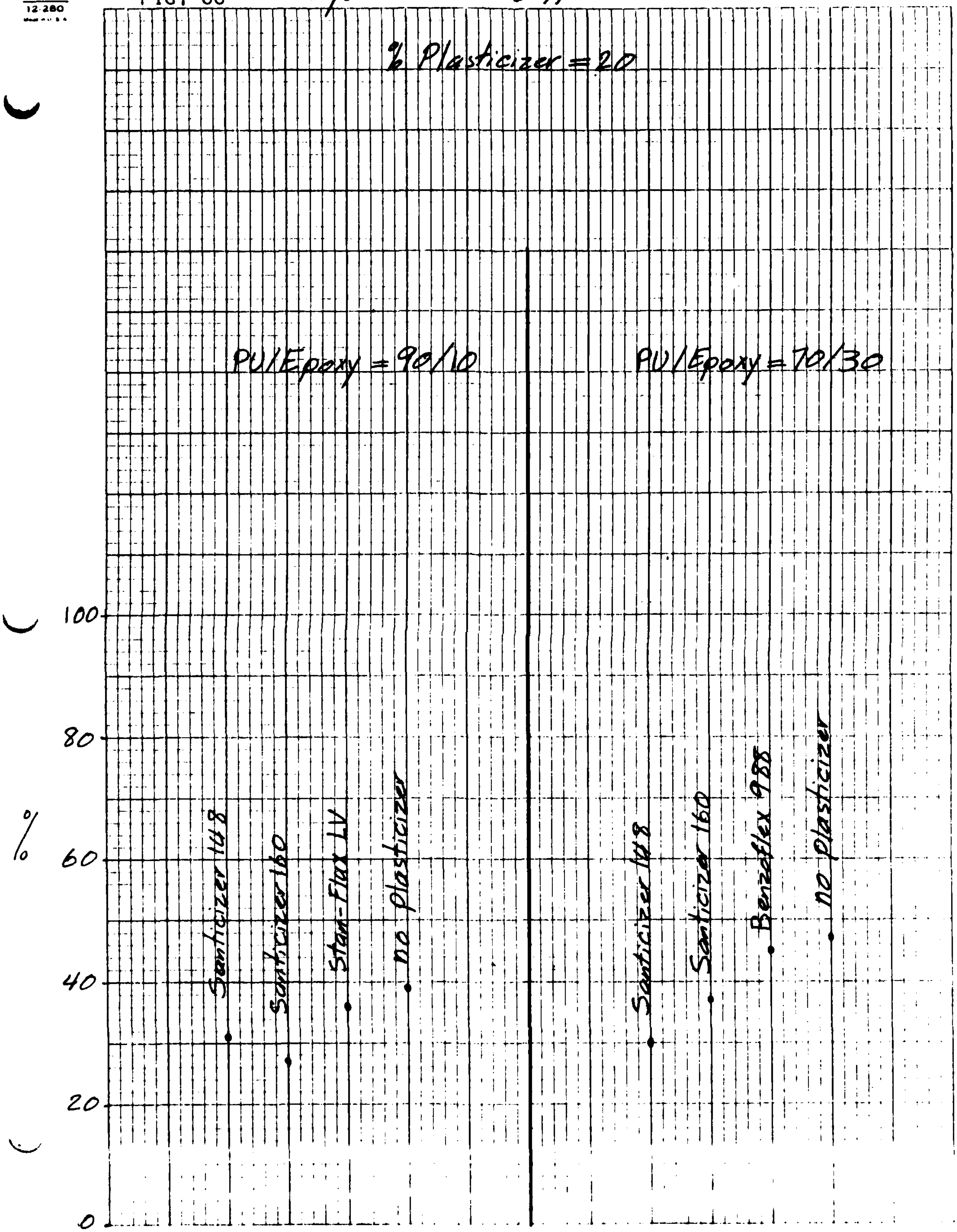
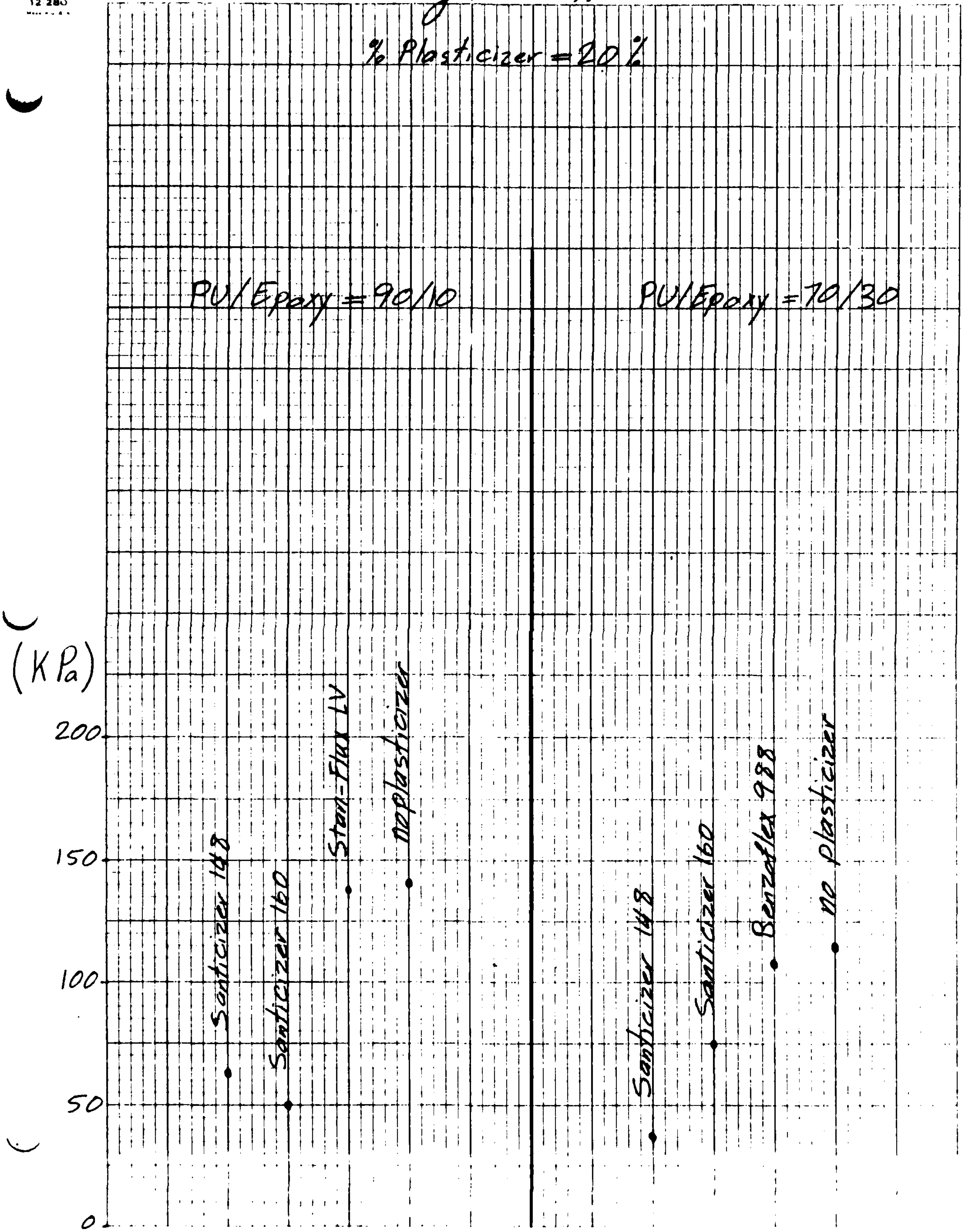
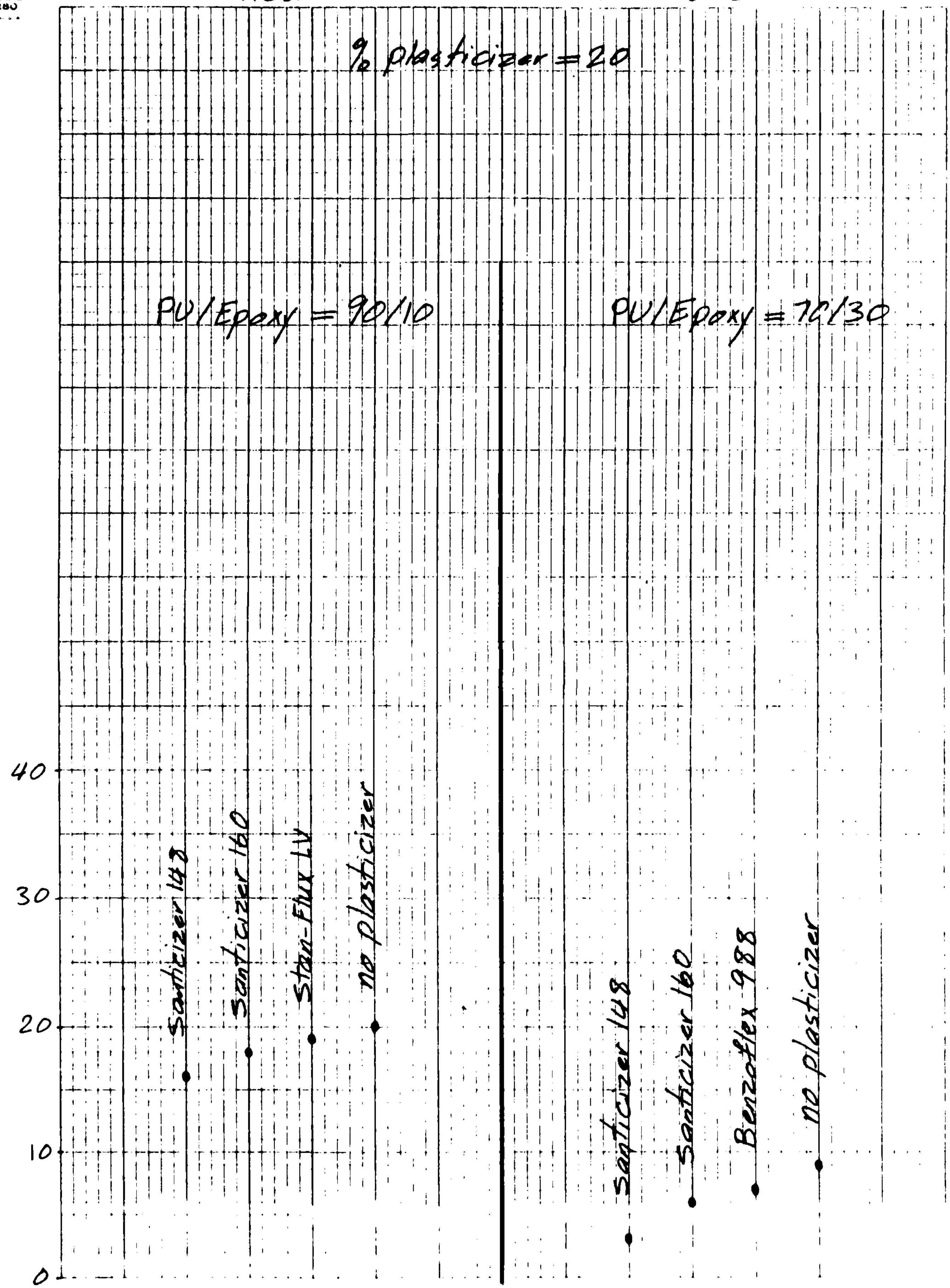


FIG. 67 Tensile Strength For Different Plasticizers



10 Squares to the Inch

FIG. 68 Rebound For Different Plasticizers



10 Squares to the Inch

FIG. 69 Relative Sound Absorption For 0-500 Hz vs. Density

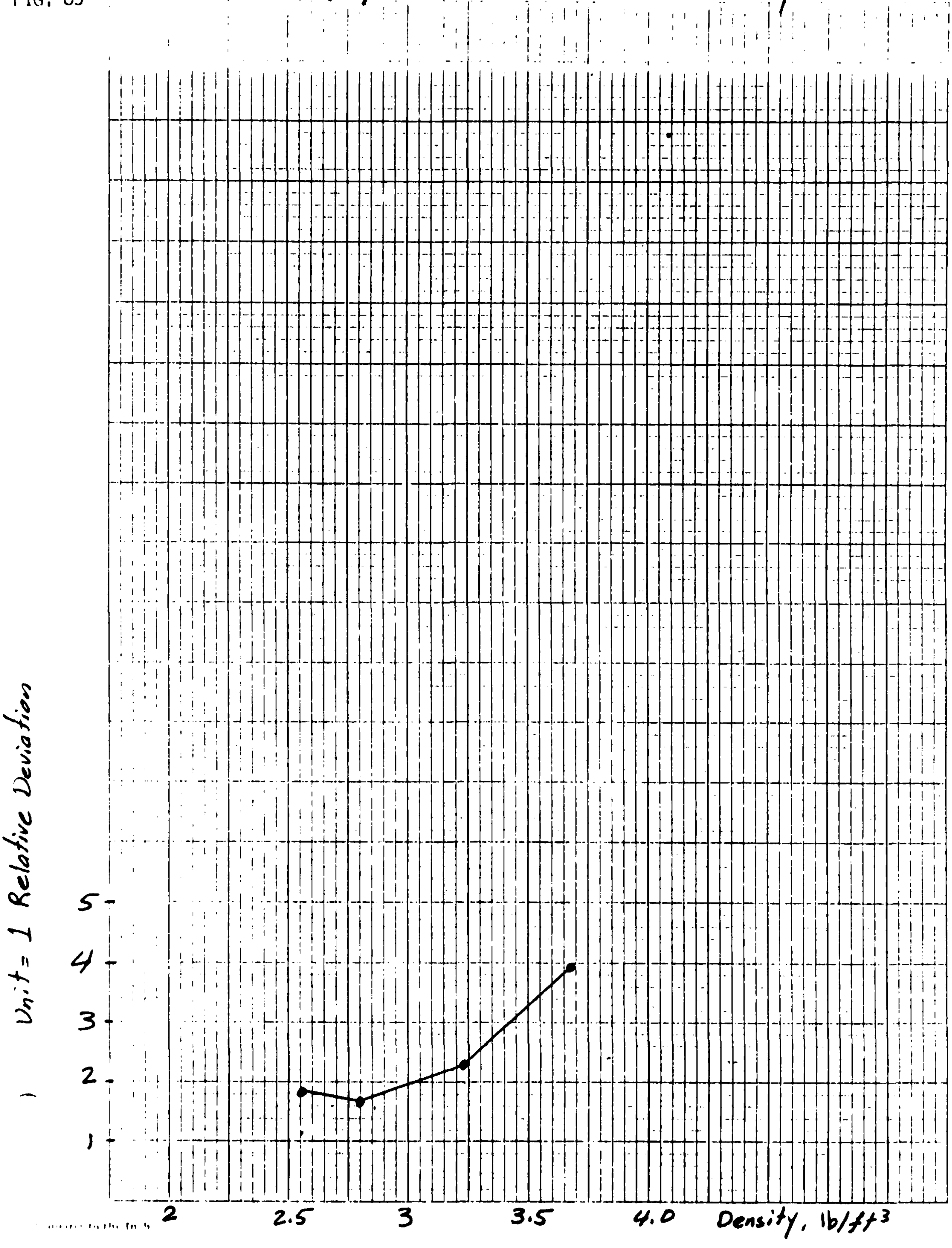


FIG. 70 Relative Sound Absorption For 500-8000 Hz vs. Density

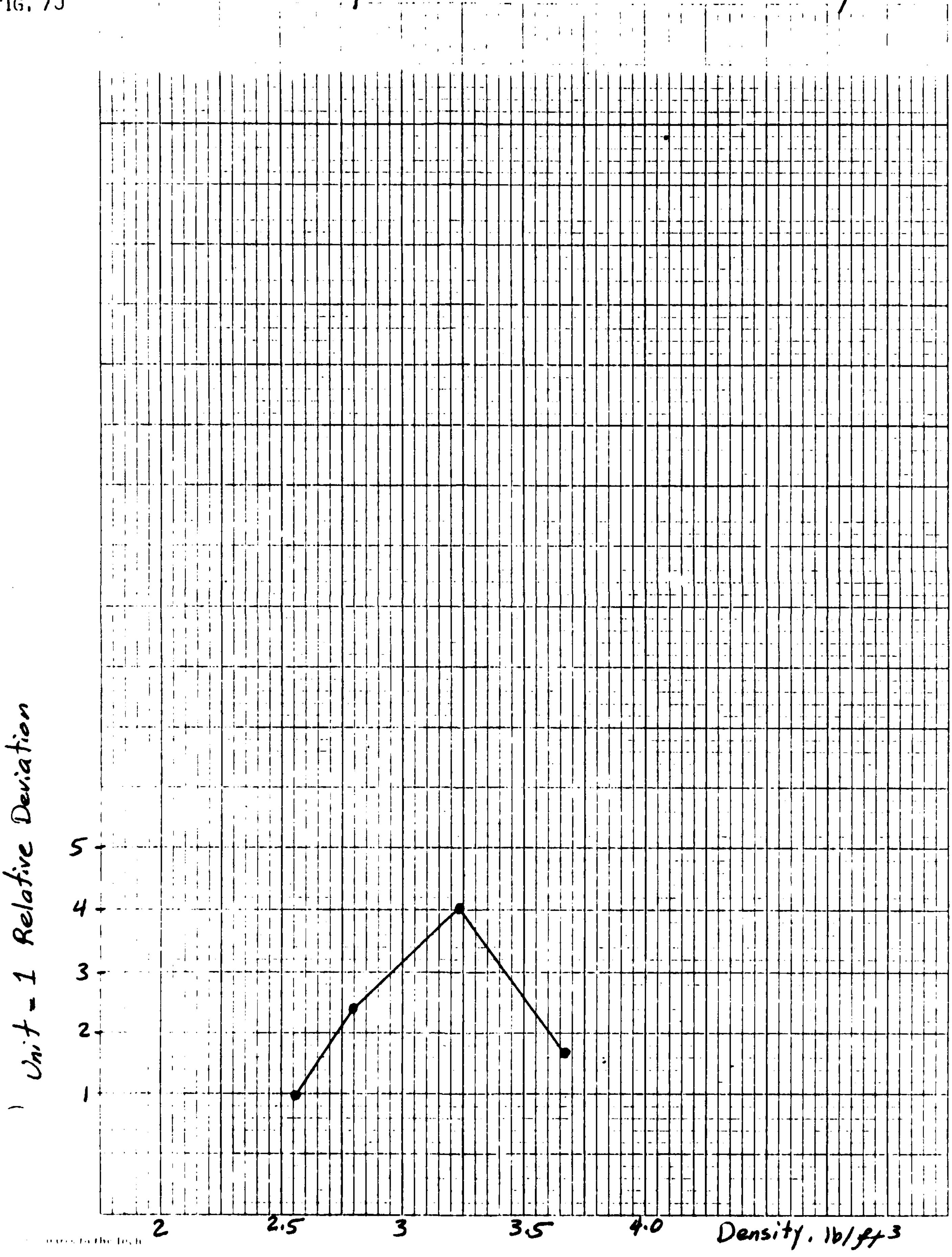


FIG. 71 Relative Sound Absorption For 0-8000 Hz vs. Density

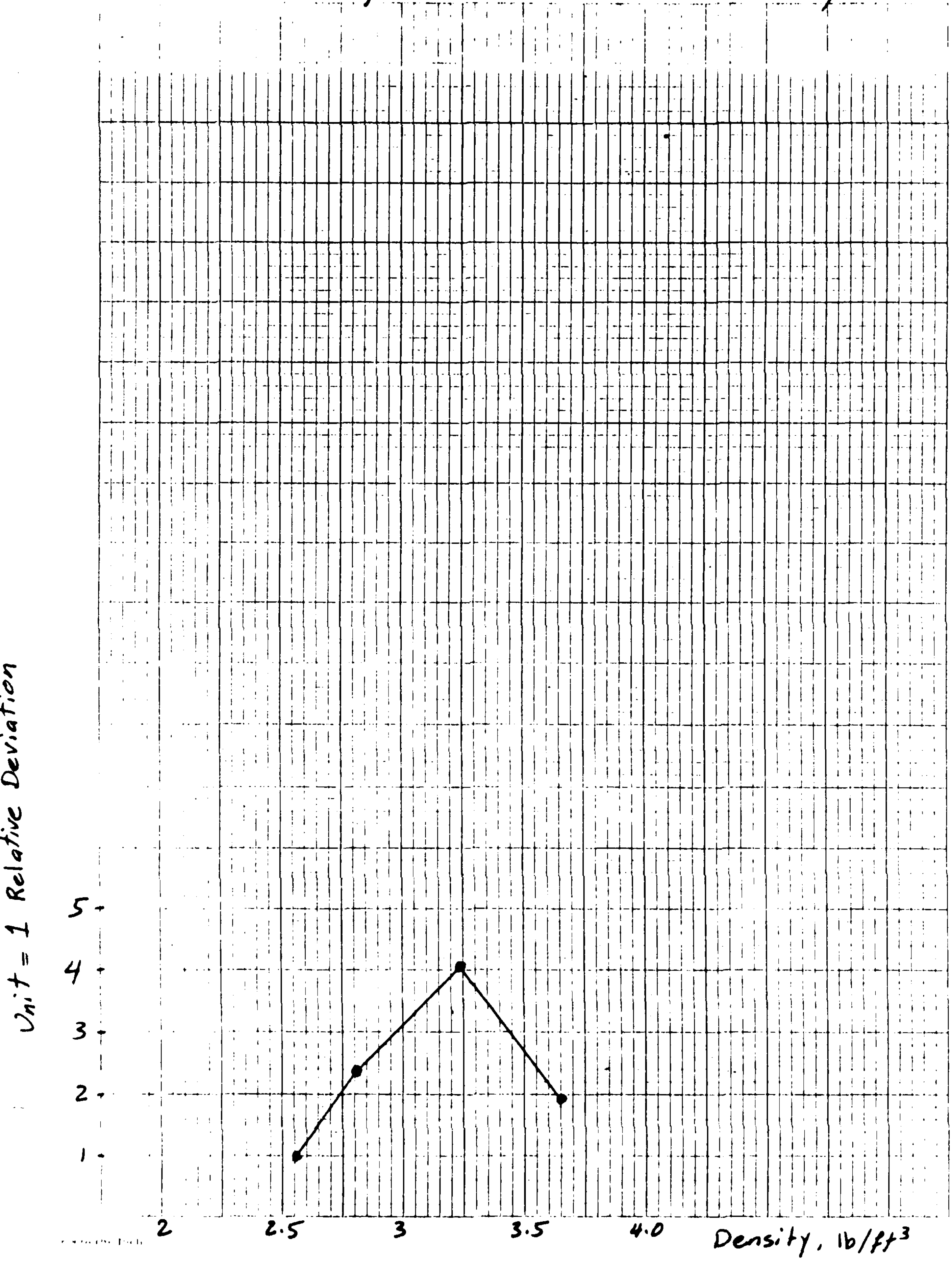
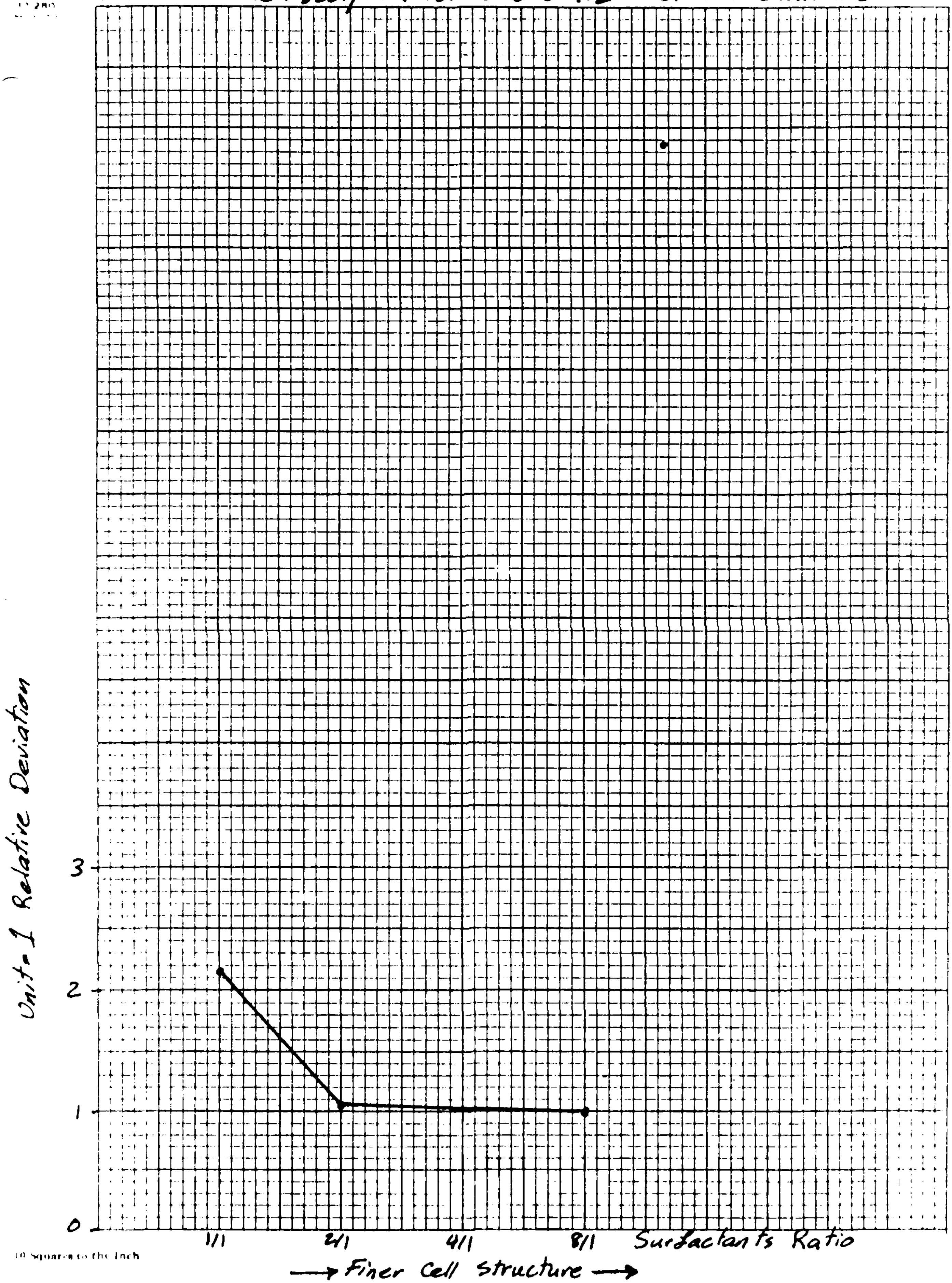


FIG. 72

Relative Sound Absorption For 0-500 Hz VS. Cell Structure



10 Squares to the Inch

FIG. 73 Relative Sound Absorption for 500-8000 Hz vs. cell structure

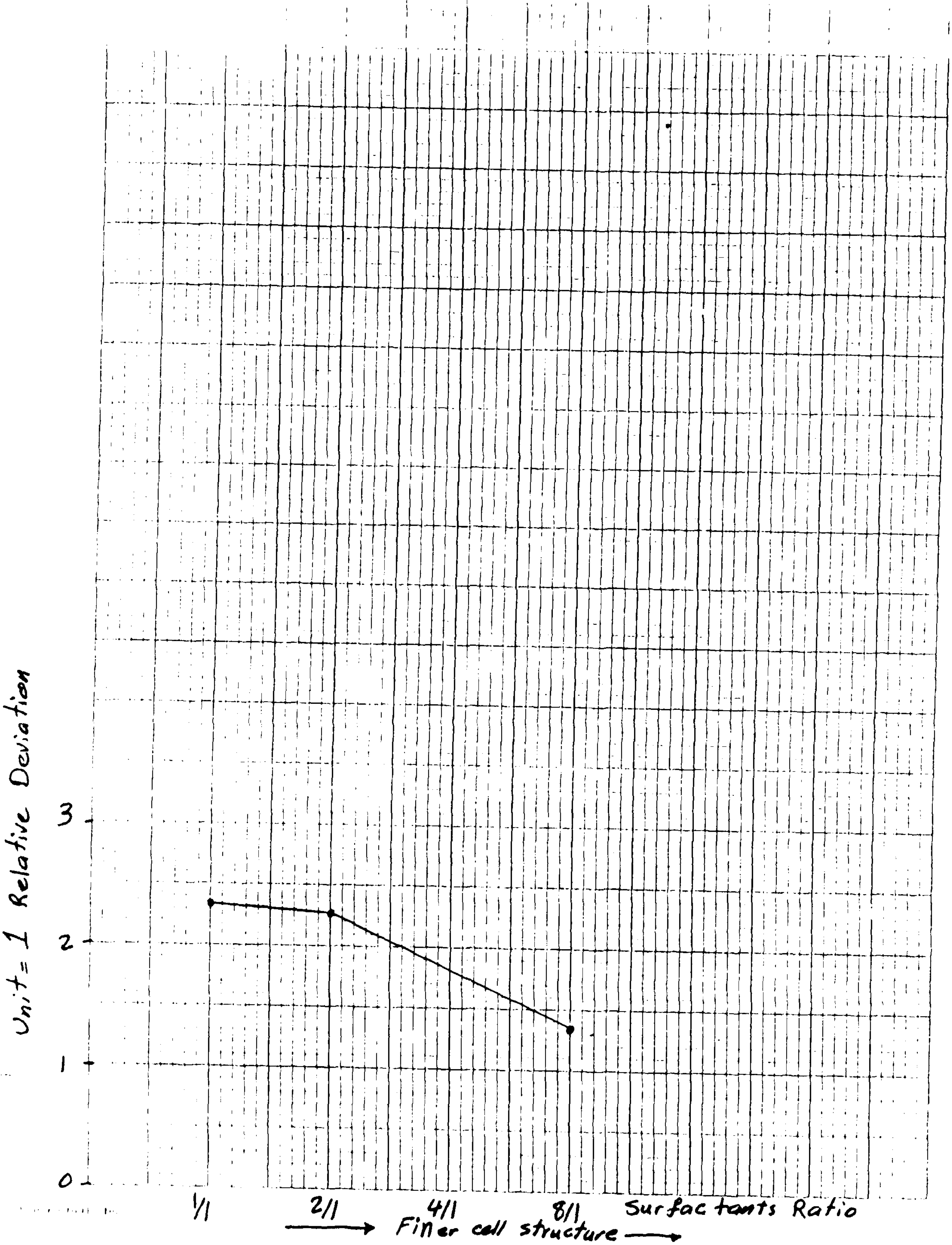


FIG. 74 Relative Sound Absorption For 0-8000 Hz vs. cell structure

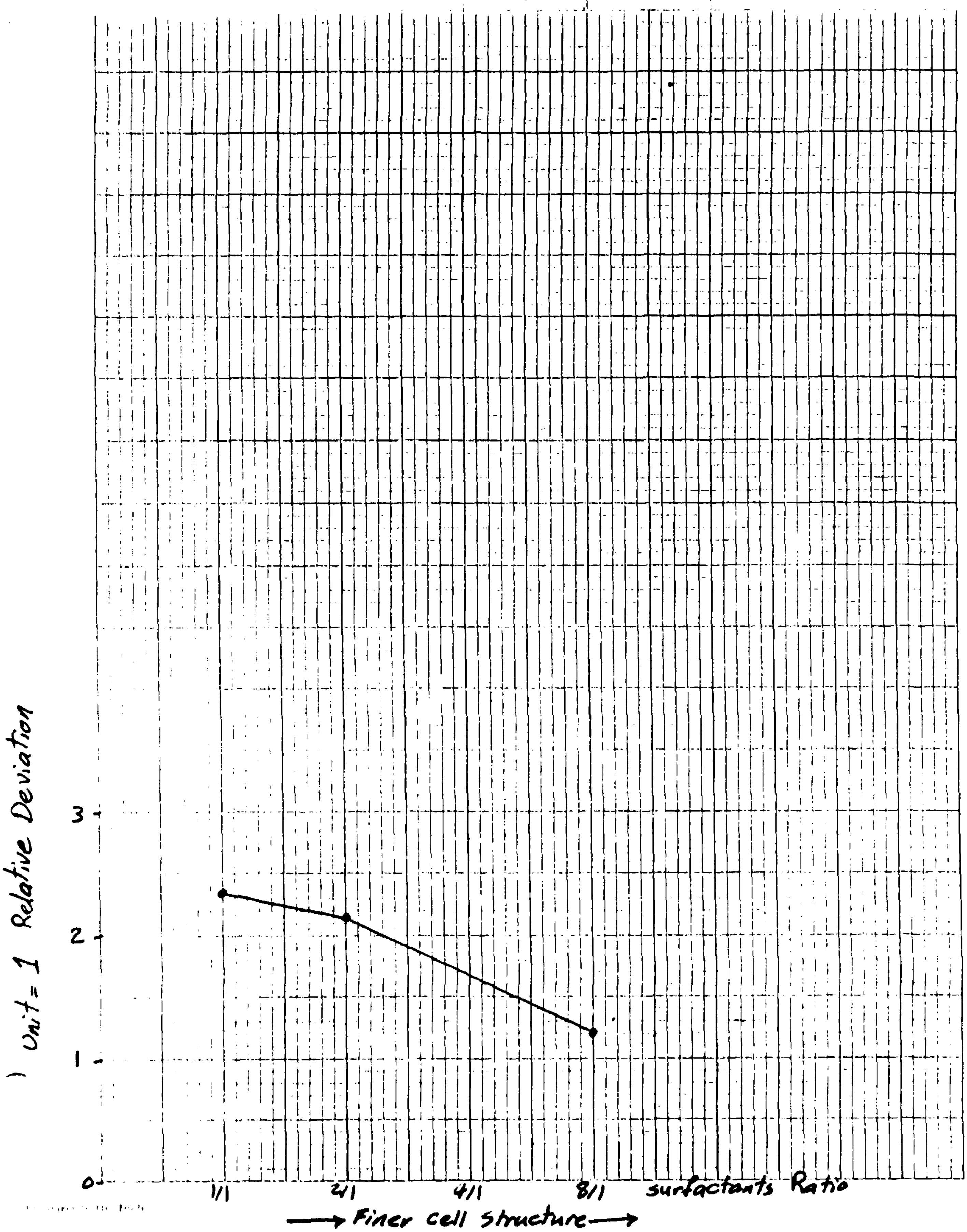
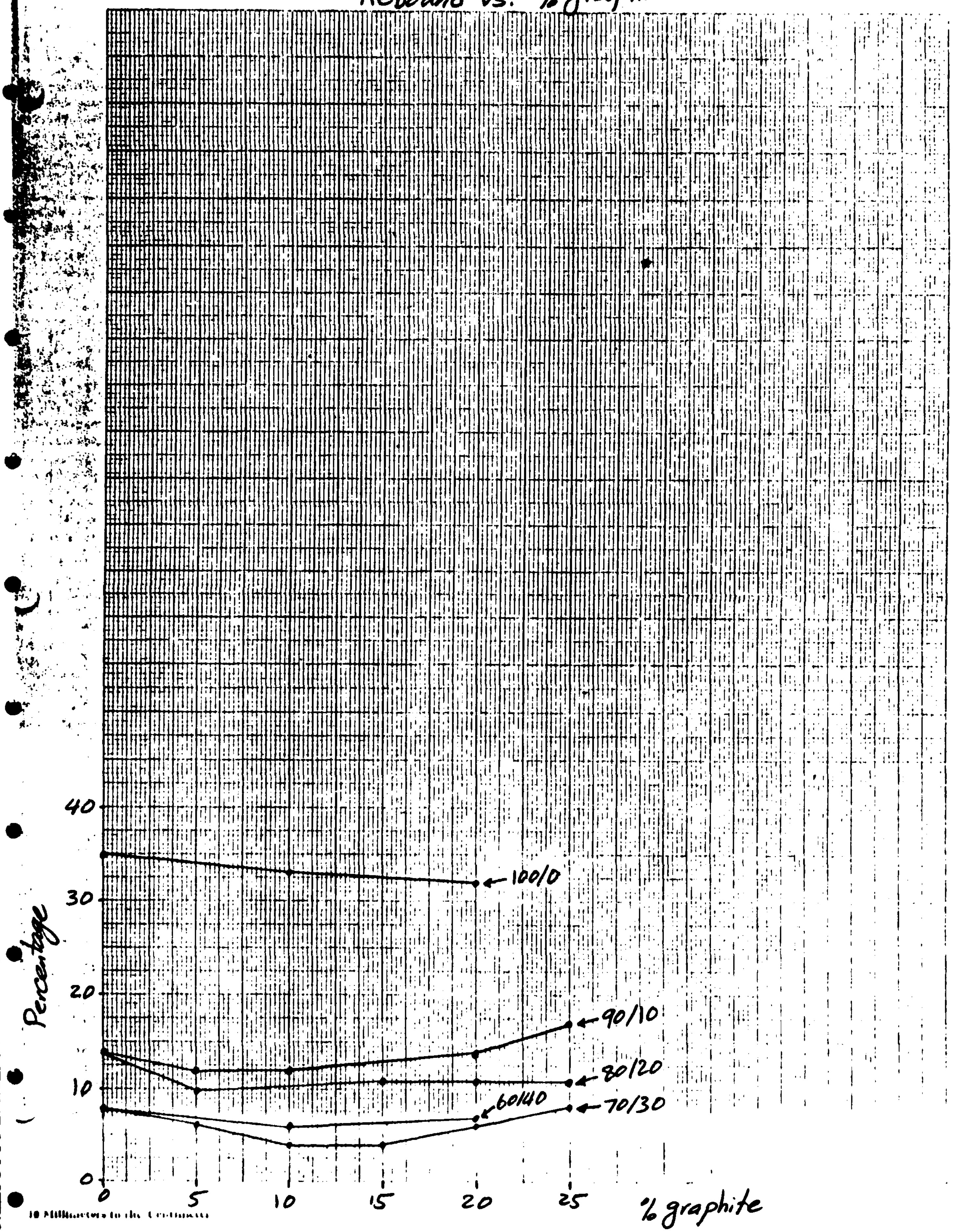
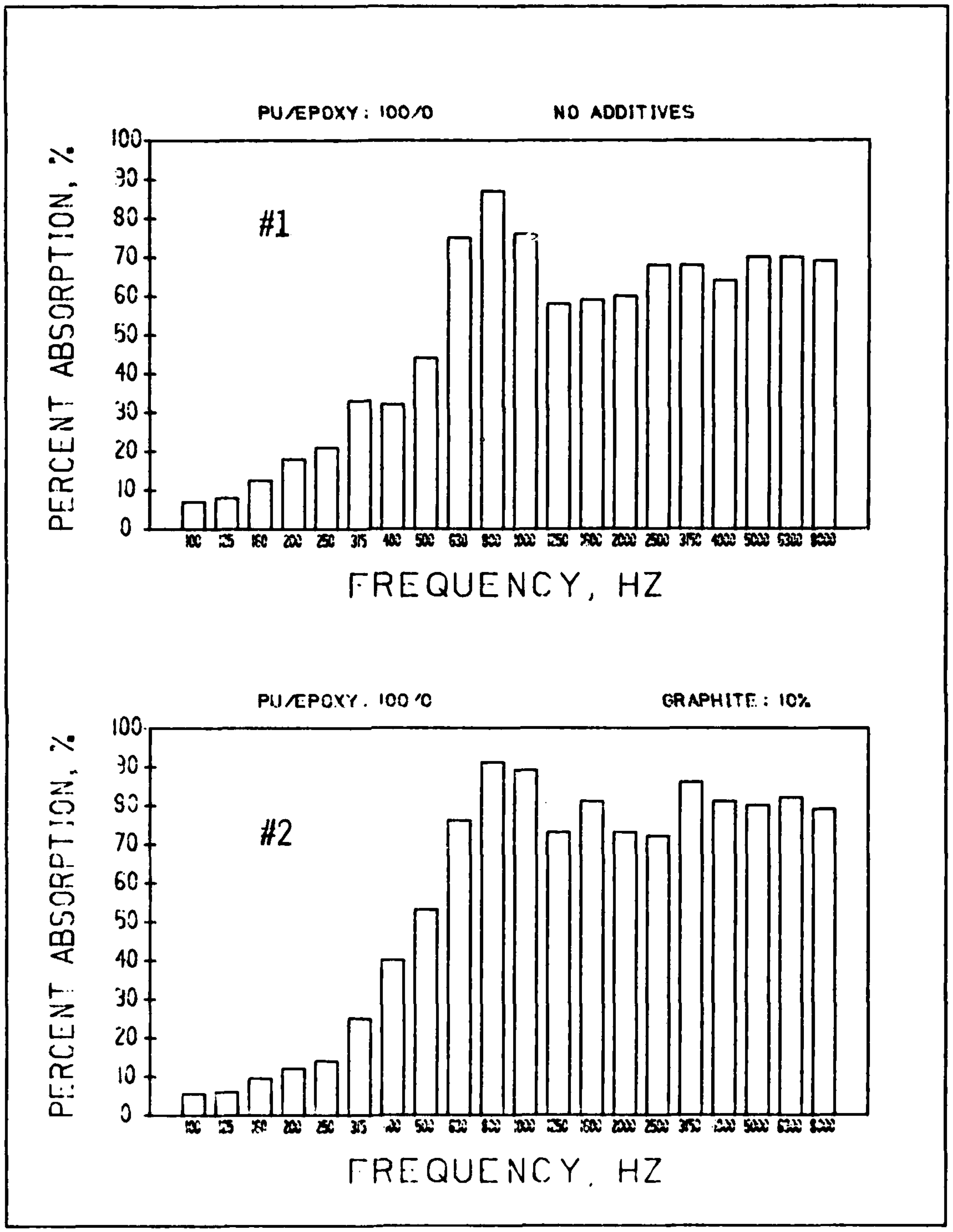
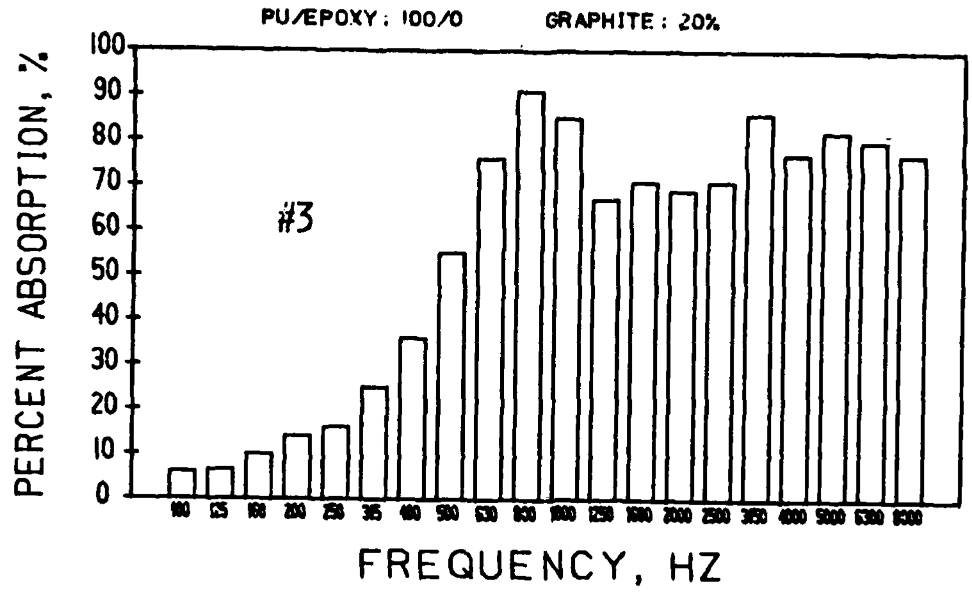


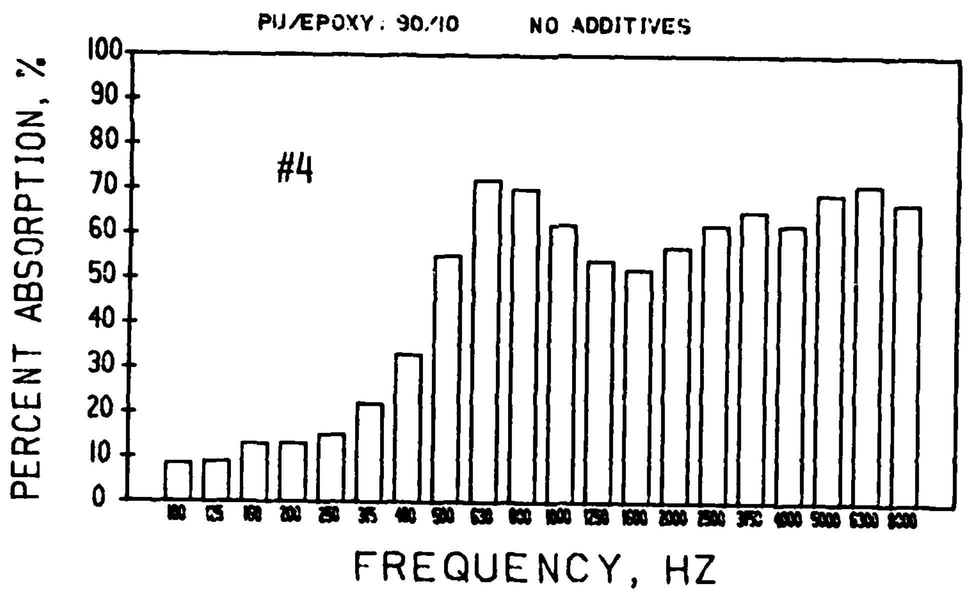
FIG. 75 Rebound vs. % graphite

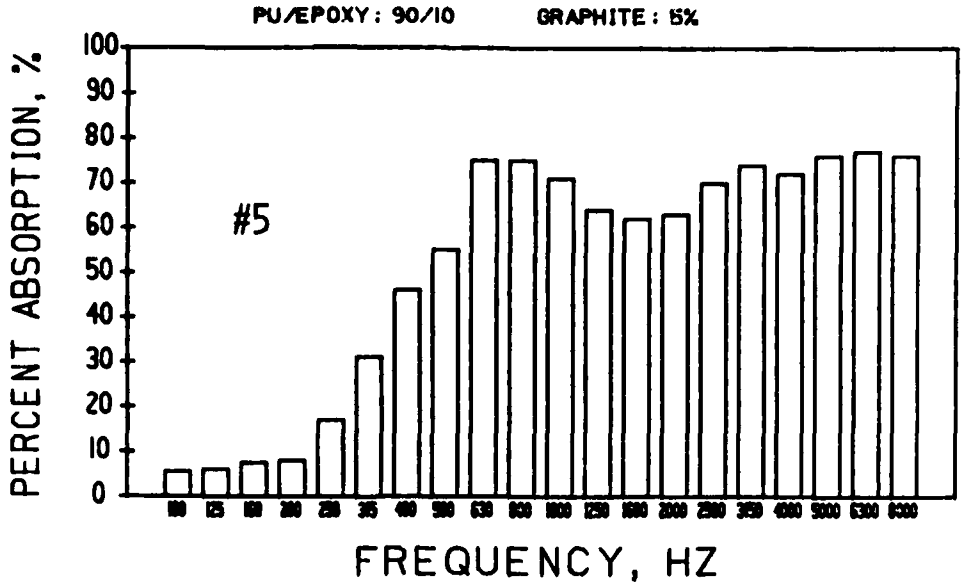


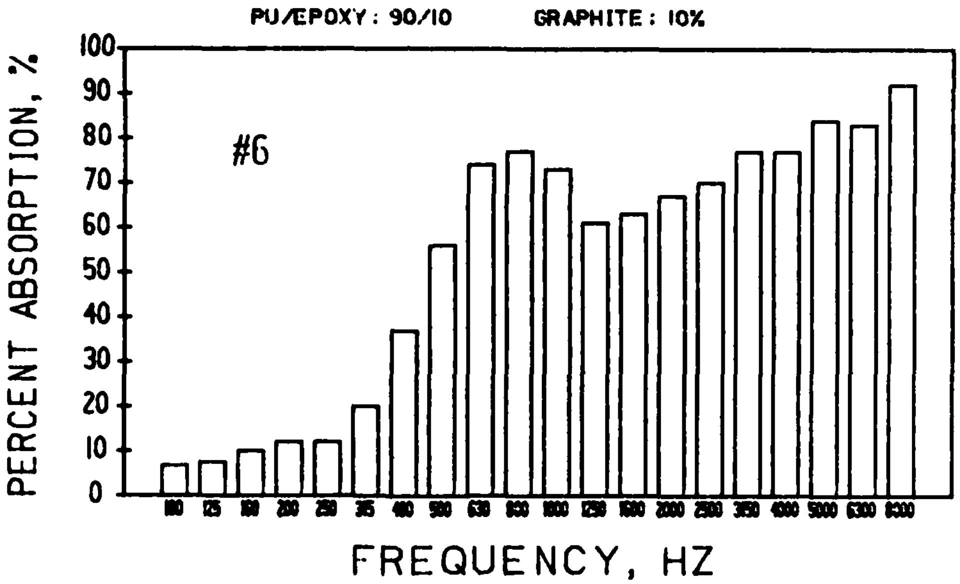
APPENDIX A PERCENT ABSORPTION VS. FREQUENCY, HZ

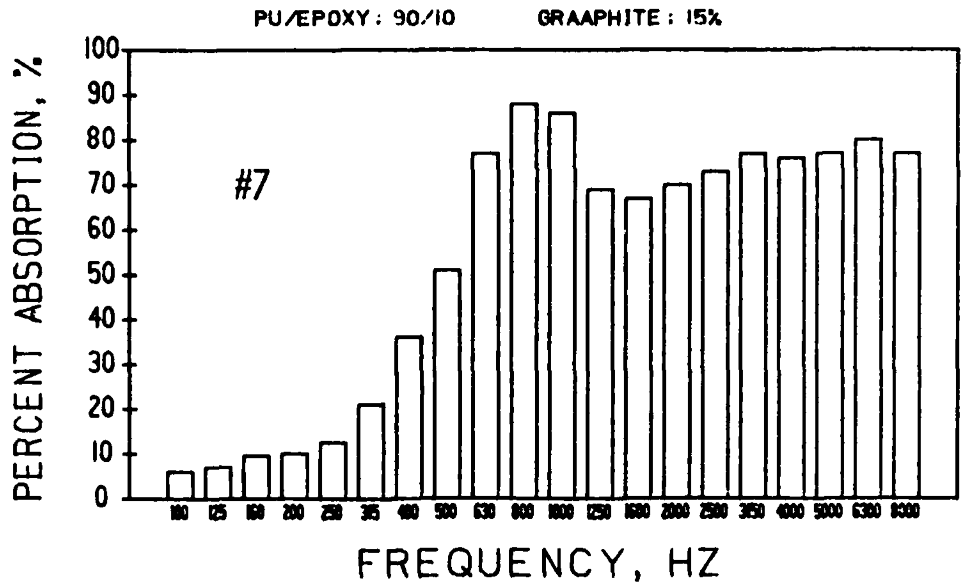


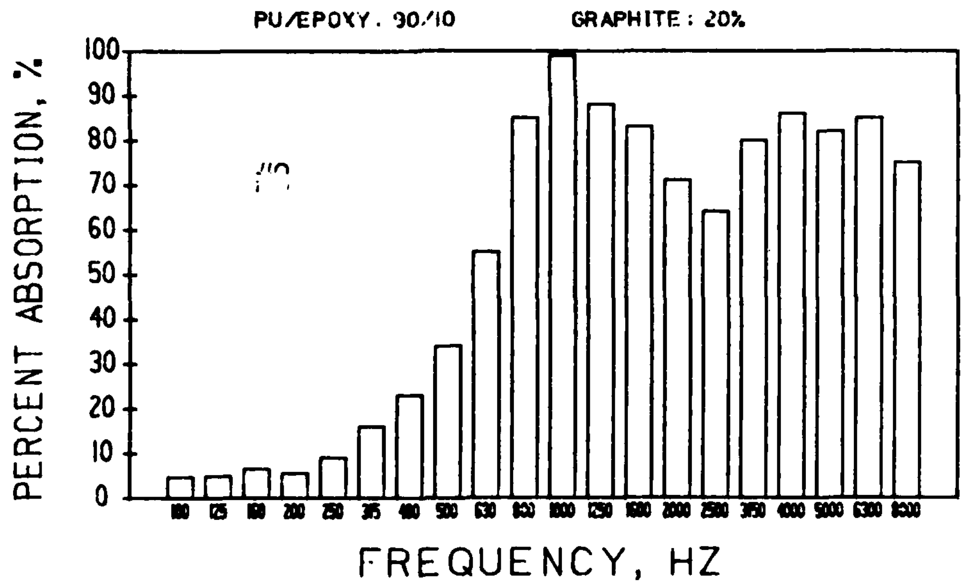

PU/EPOXY: 100/0
GRAPHITE: 20%
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
#3
FREQUENCY, HZ

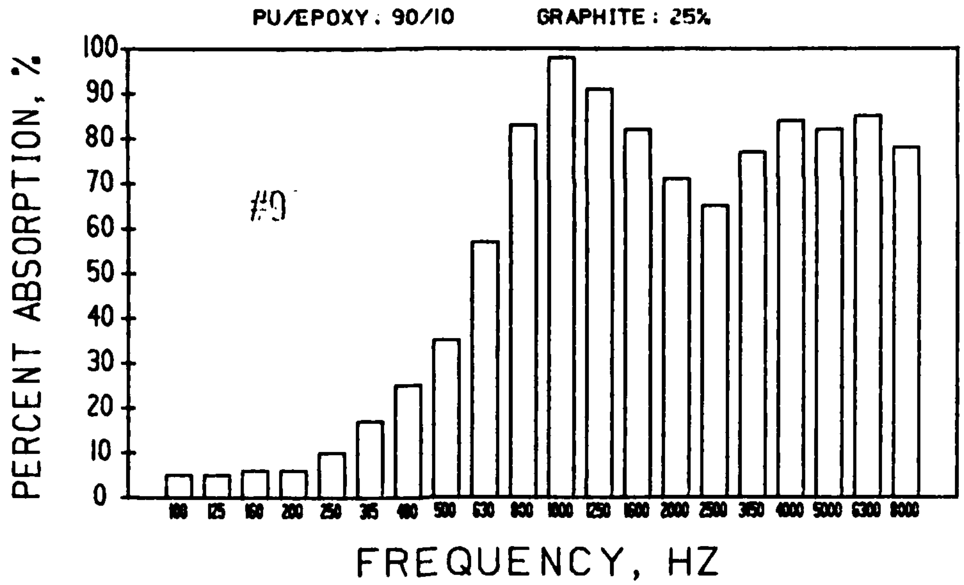

PU/EPOXY: 90/10
NO ADDITIVES
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
#4
FREQUENCY, HZ

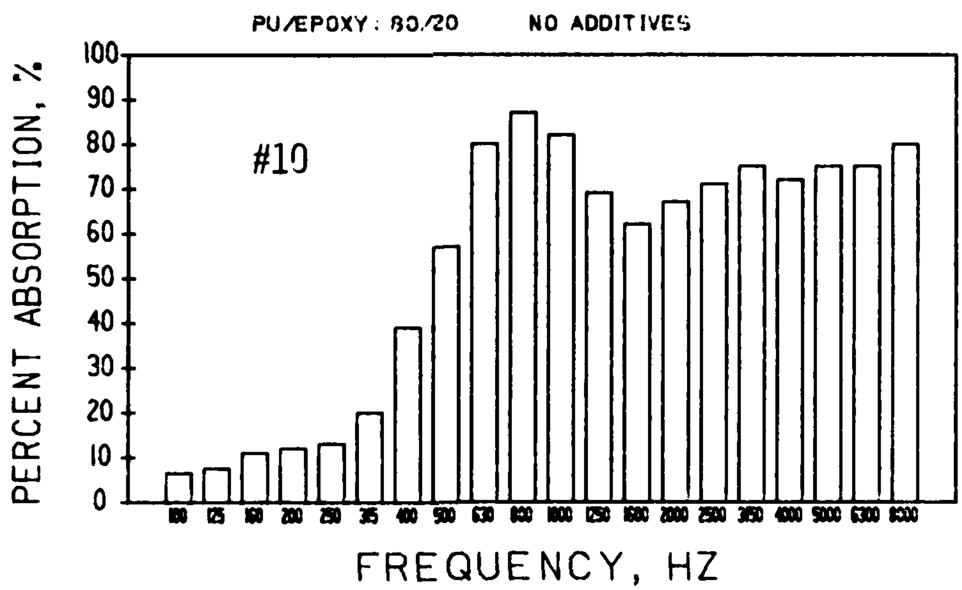

PU/EPOXY: 90/10 GRAPHITE: 5%
#5
PERCENT ABSORPTION, %
FREQUENCY, HZ

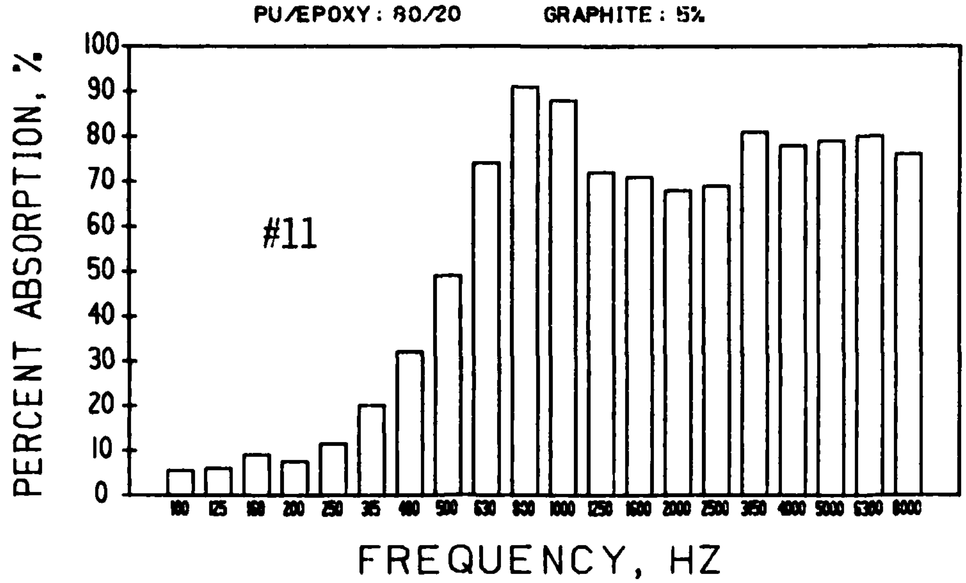

PU/EPOXY: 90/10 GRAPHITE: 10%
#6
PERCENT ABSORPTION, %
FREQUENCY, HZ

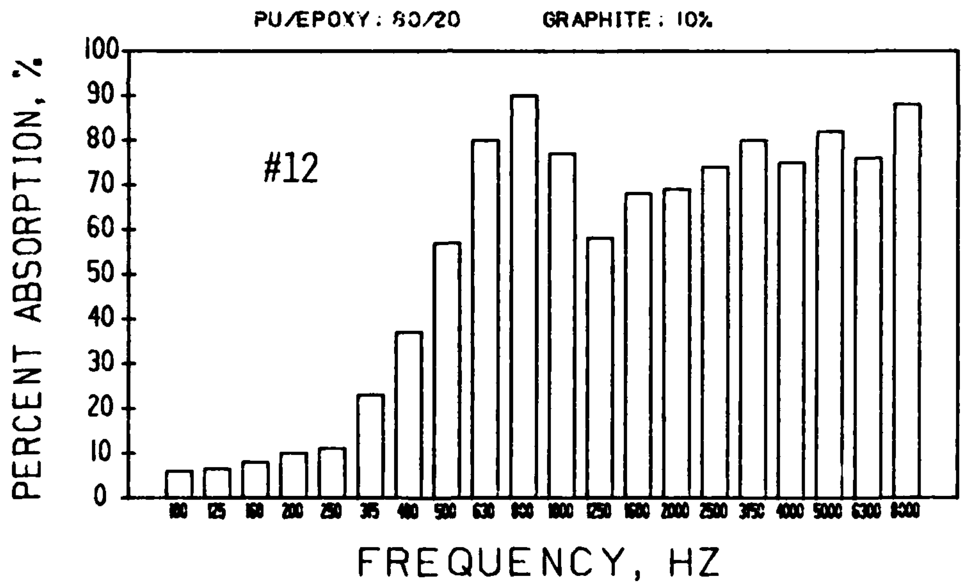

PU/EPOXY: 90/10
GRAAPHITE: 15%
#7
PERCENT ABSORPTION, %
FREQUENCY, HZ

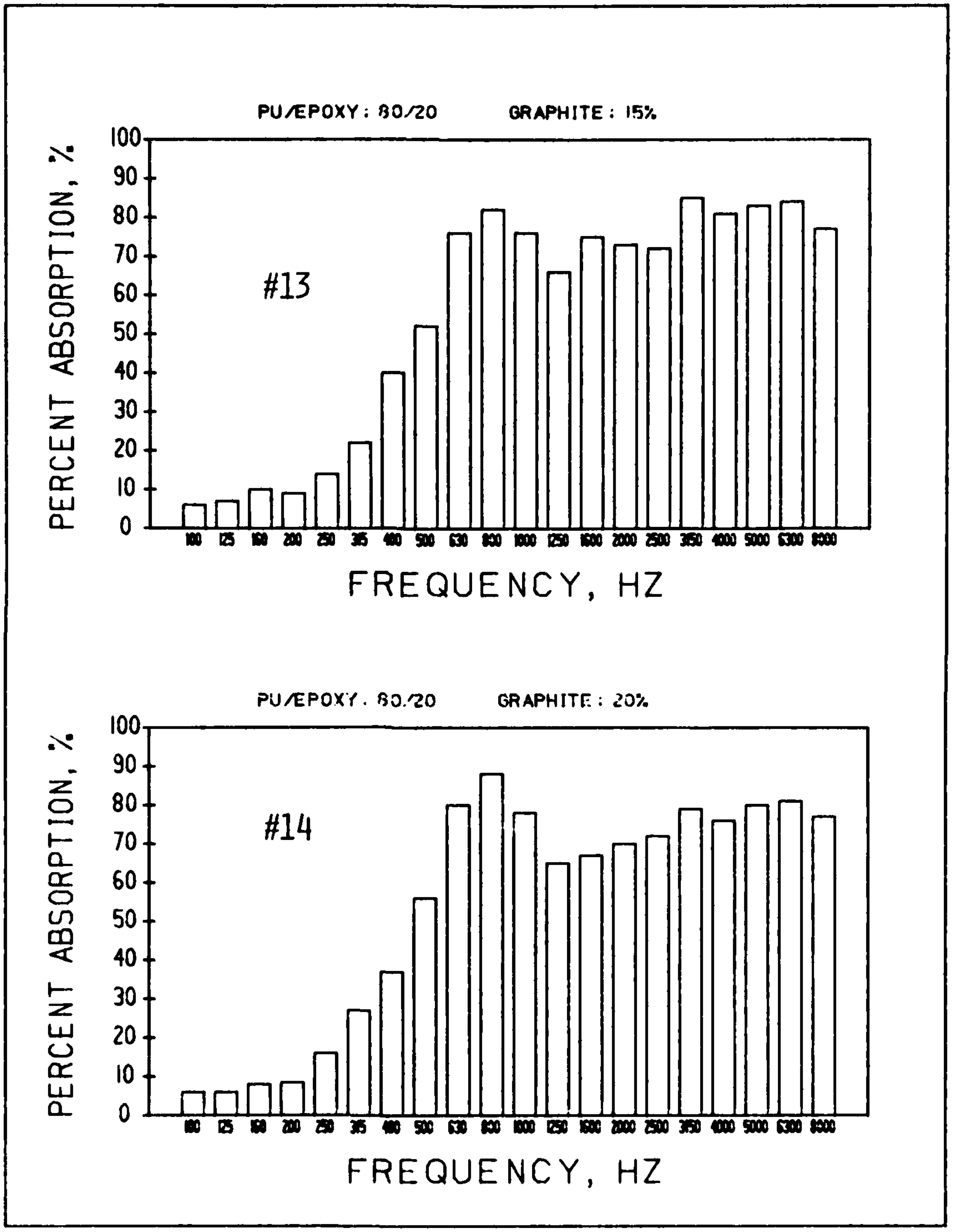

PU/EPOXY. 90/10
GRAPHITE: 20%
PERCENT ABSORPTION, %
FREQUENCY, HZ

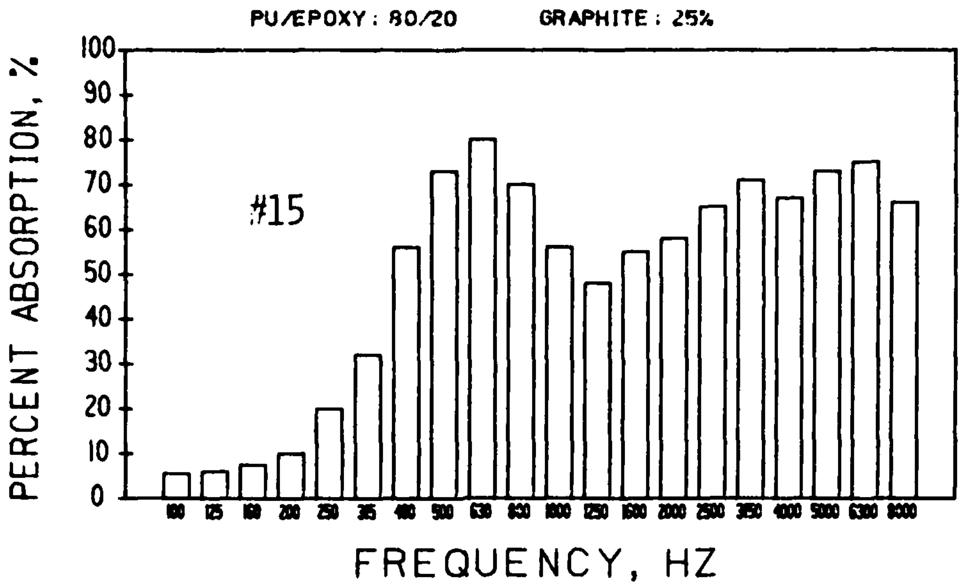

PU/EPOXY: 90/10 GRAPHITE: 25%
PERCENT ABSORPTION, %
#9
FREQUENCY, HZ

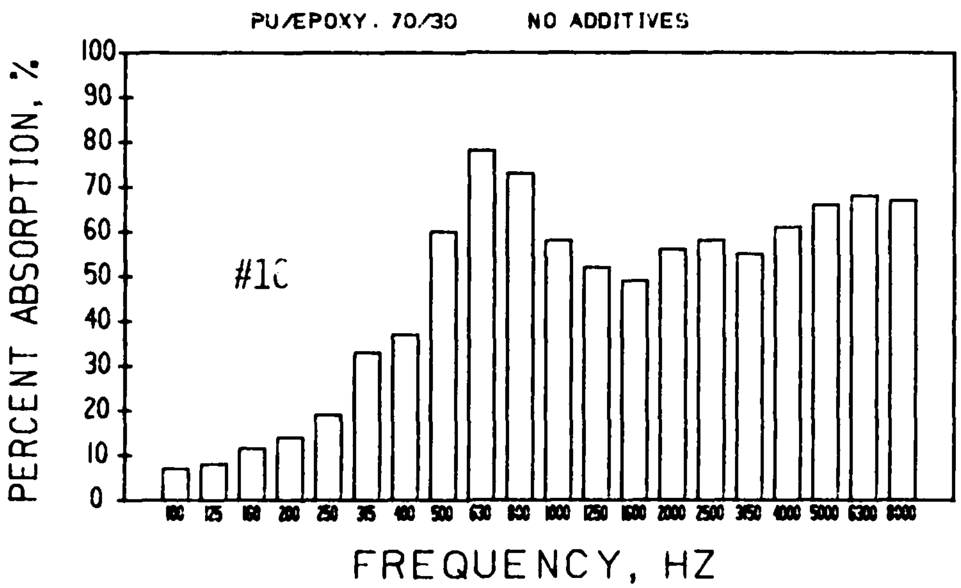

PU/EPOXY: 80/20 NO ADDITIVES
PERCENT ABSORPTION, %
#10
FREQUENCY, HZ

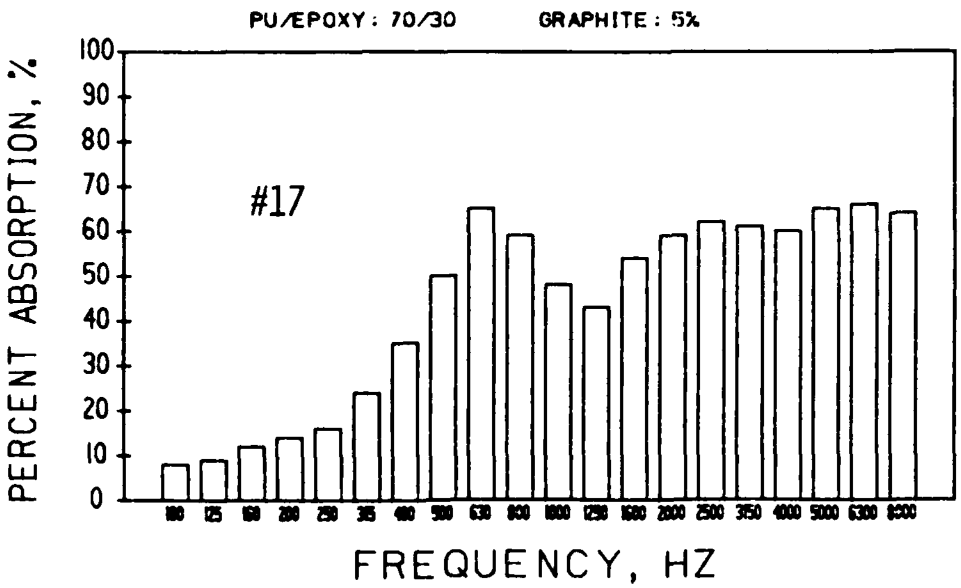

PU/EPOXY : 80/20
GRAPHITE : 5%
#11
PERCENT ABSORPTION, %
0
10
20
30
40
50
60
70
80
90
100
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
FREQUENCY, HZ

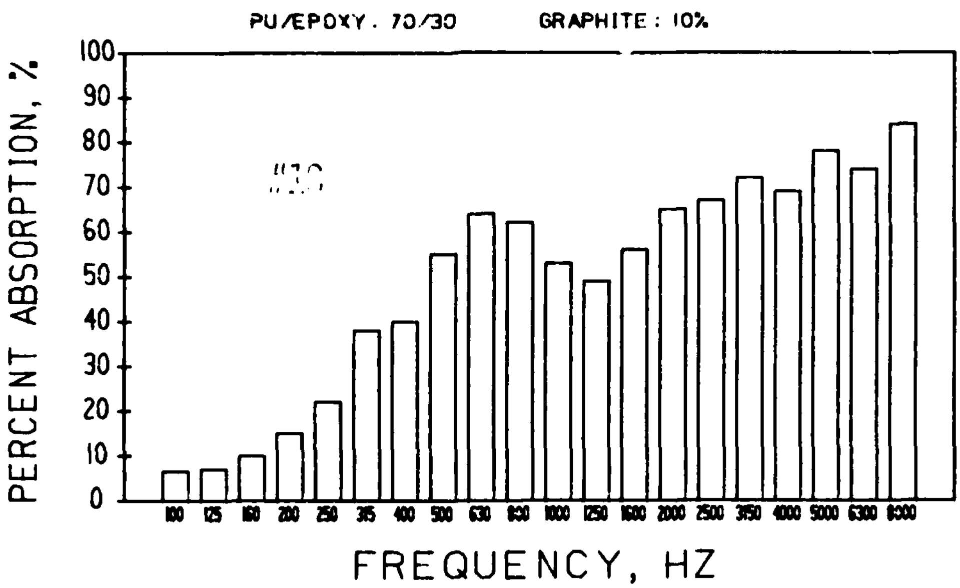

PU/EPOXY : 80/20
GRAPHITE : 10%
#12
PERCENT ABSORPTION, %
0
10
20
30
40
50
60
70
80
90
100
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
FREQUENCY, HZ

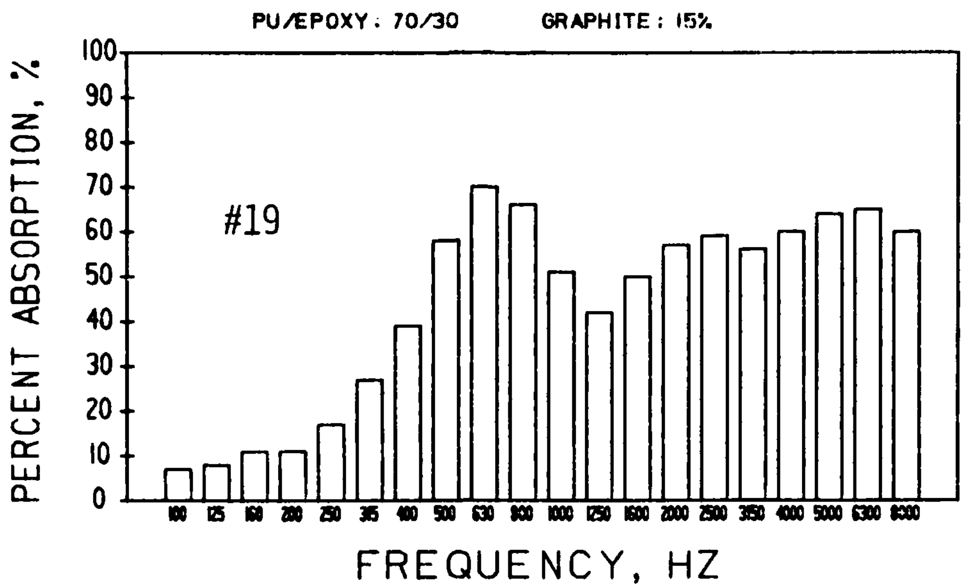

PU/EPOXY: 80/20
GRAPHITE: 15%
#13
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ
PU/EPOXY: 80/20
GRAPHITE: 20%
#14
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ


PU/EPOXY: 80/20 GRAPHITE: 25%
PERCENT ABSORPTION, %
0 10 20 30 40 50 60 70 80 90 100
#15
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

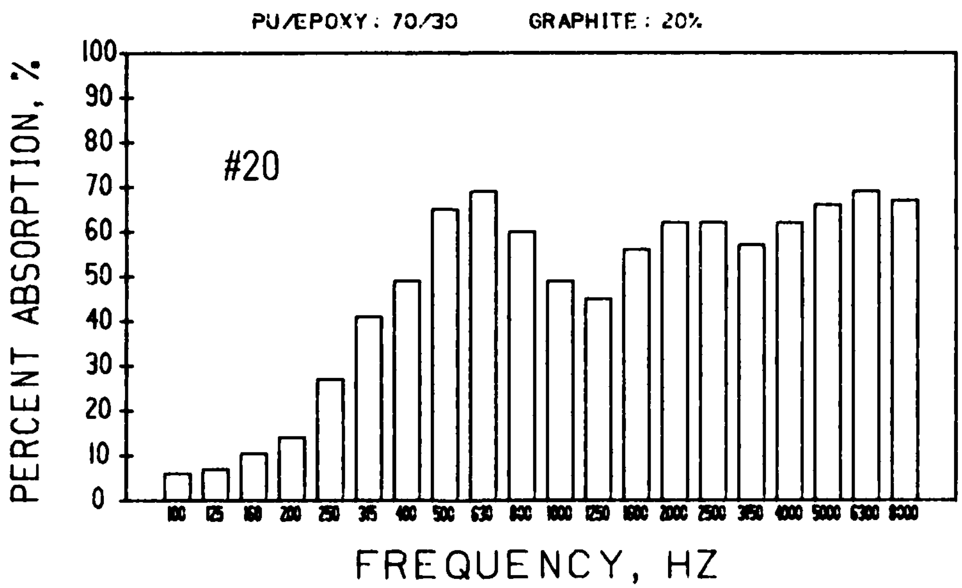

PU/EPOXY. 70/30 NO ADDITIVES
PERCENT ABSORPTION, %
0 10 20 30 40 50 60 70 80 90 100
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ


PU/EPOXY : 70/30
GRAPHITE : 5%
PERCENT ABSORPTION, %
#17
FREQUENCY, HZ

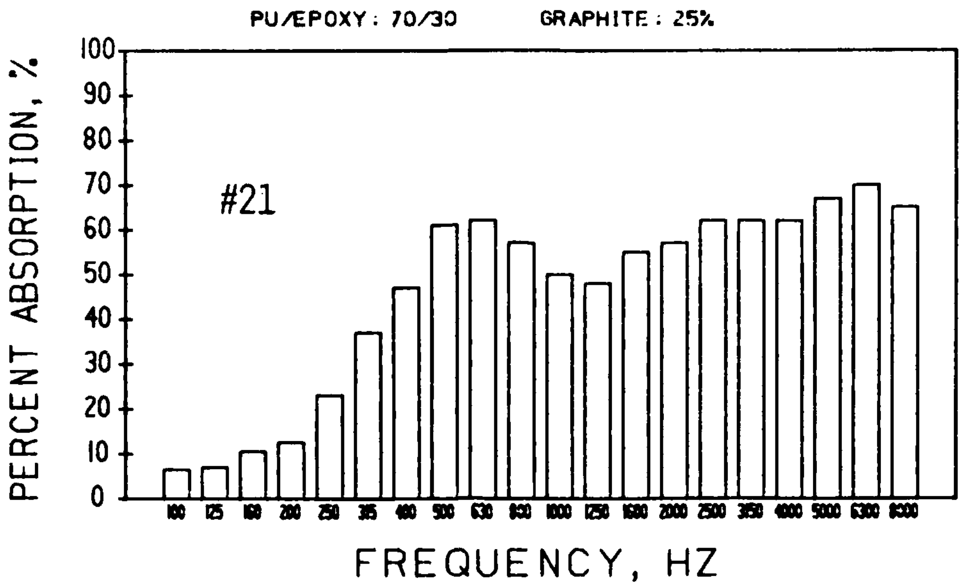

PU/EPOXY . 70/30
GRAPHITE : 10%
PERCENT ABSORPTION, %
FREQUENCY, HZ

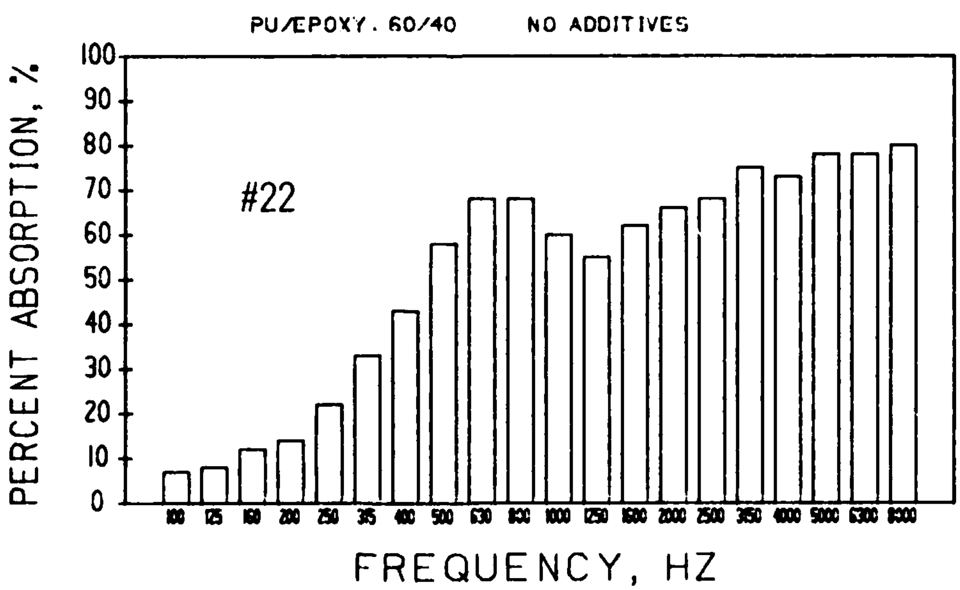


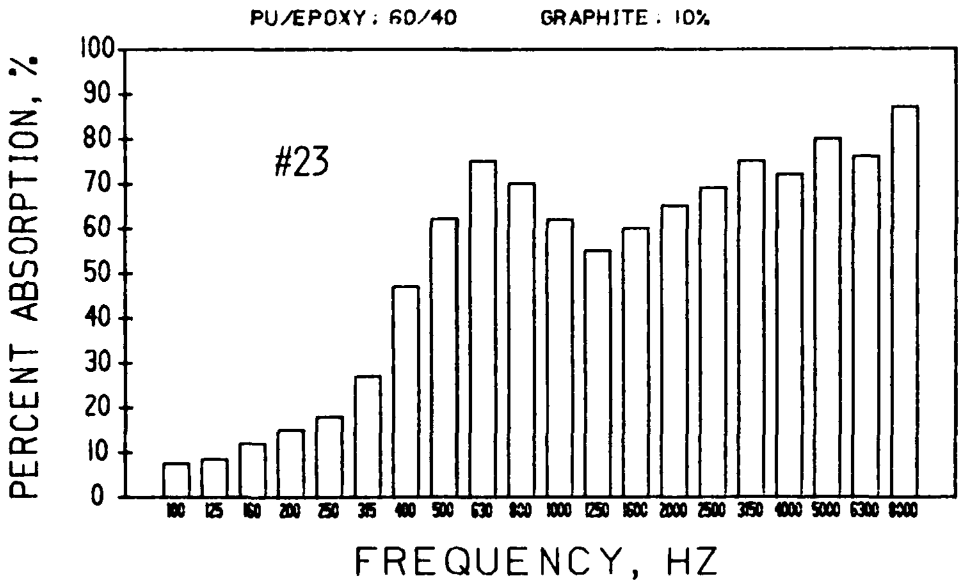
PU/EPOXY: 70/30 GRAPHITE: 15%
PERCENT ABSORPTION, %
#19
0
10
20
30
40
50
60
70
80
90
100
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

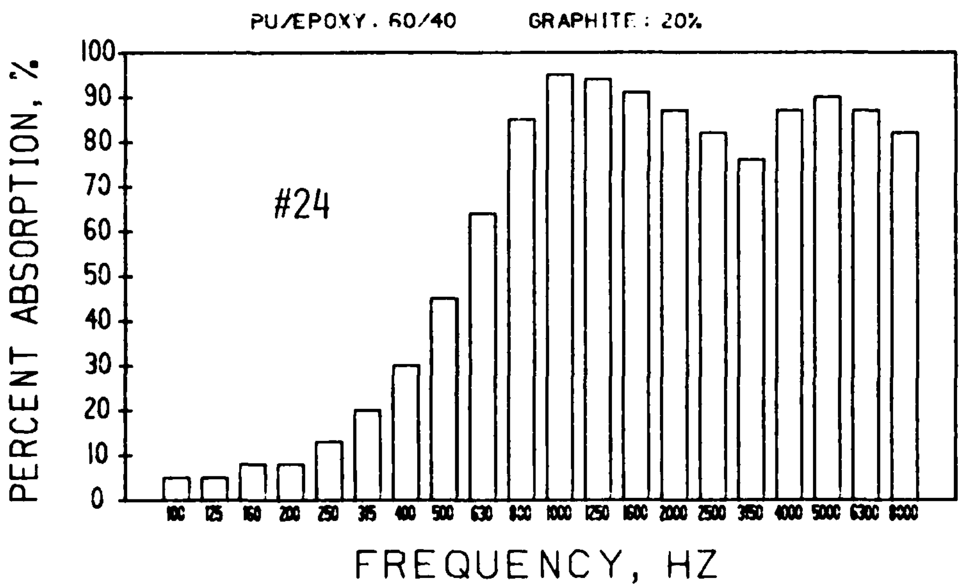


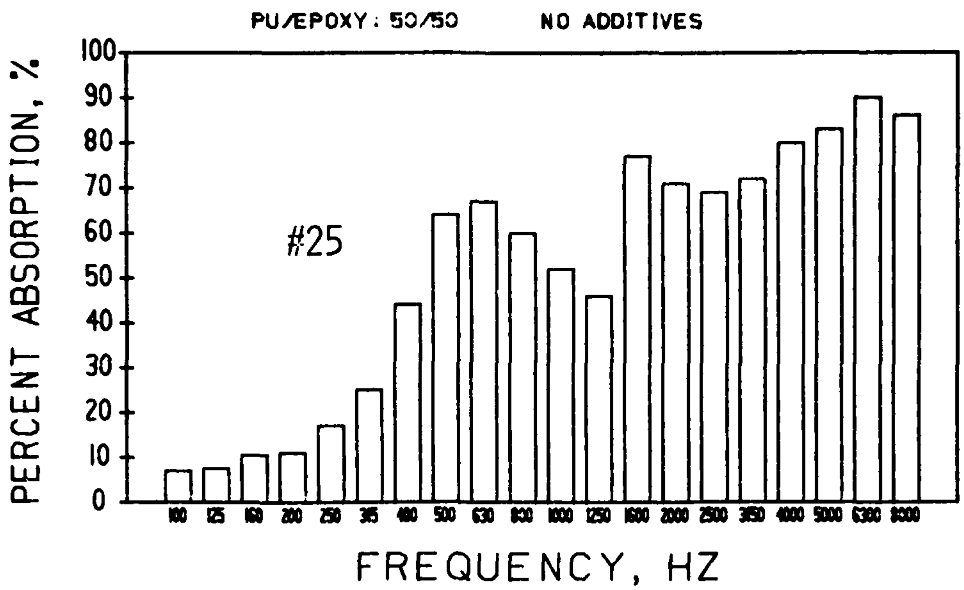
PU/EPOXY: 70/30 GRAPHITE: 20%
PERCENT ABSORPTION, %
#20
0
10
20
30
40
50
60
70
80
90
100
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

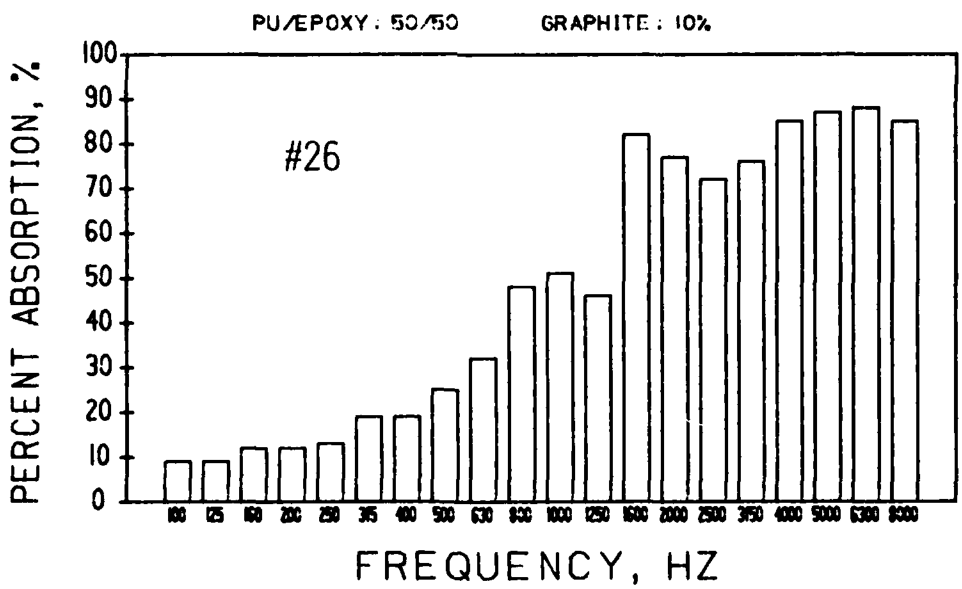

PU/EPOXY: 70/30
GRAPHITE: 25%
#21
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

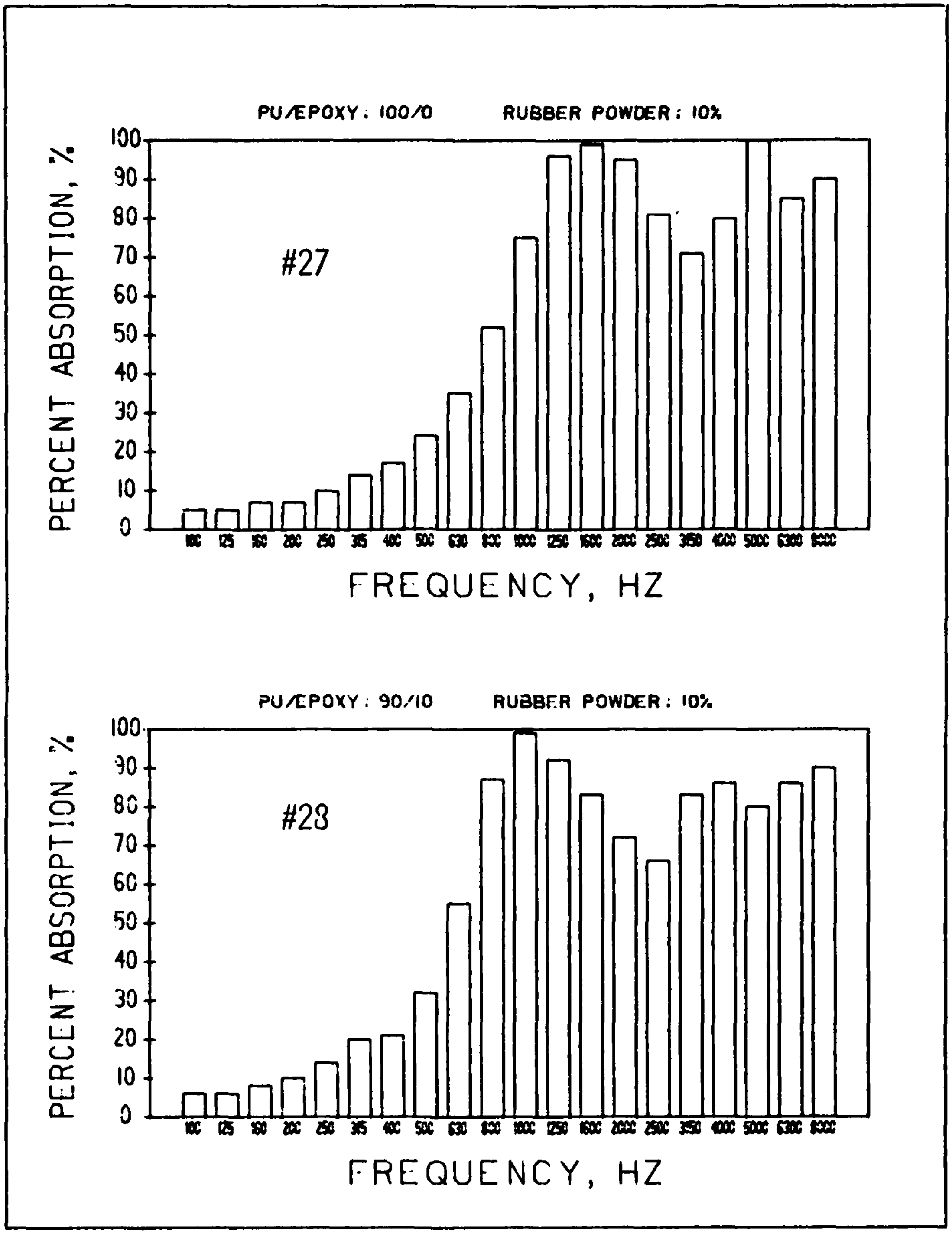

PU/EPOXY. 60/40
NO ADDITIVES
#22
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ


PU/EPOXY: 60/40
GRAPHITE: 10%
PERCENT ABSORPTION, %
#23
100
90
80
70
60
50
40
30
20
10
0
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

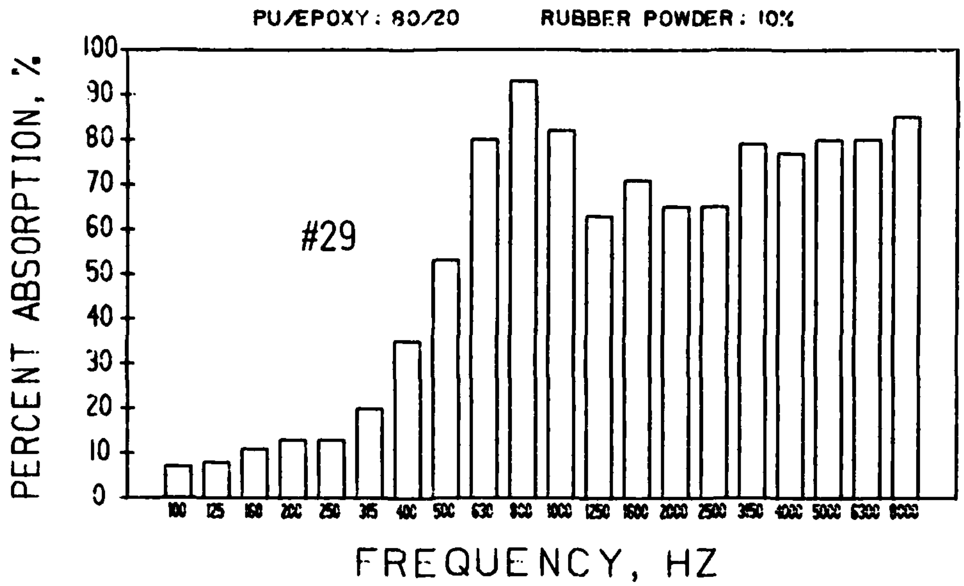

PU/EPOXY. 60/40
GRAPHITE: 20%
PERCENT ABSORPTION, %
#24
100
90
80
70
60
50
40
30
20
10
0
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

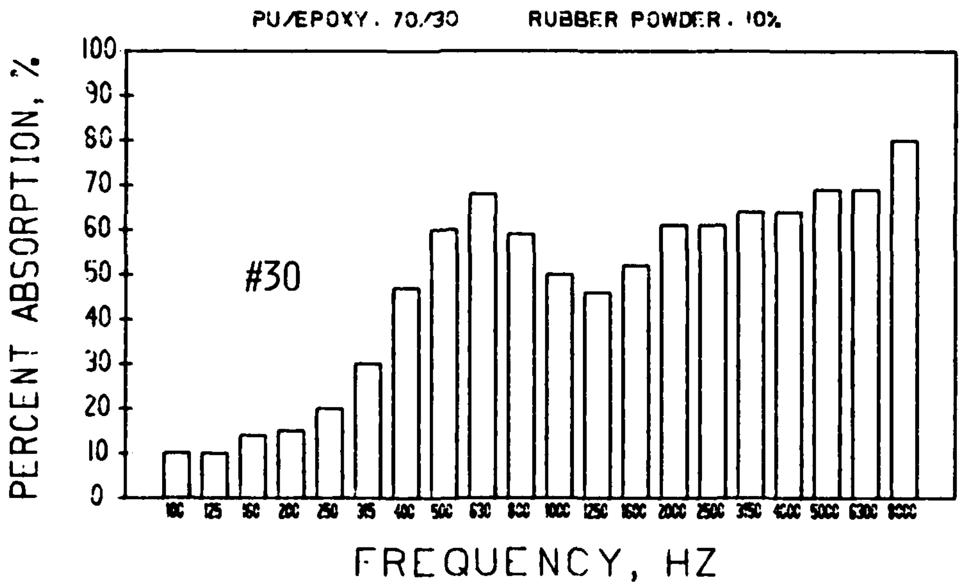

PU/EPOXY : 50/50 NO ADDITIVES
#25
PERCENT ABSORPTION, %
0
10
20
30
40
50
60
70
80
90
100
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

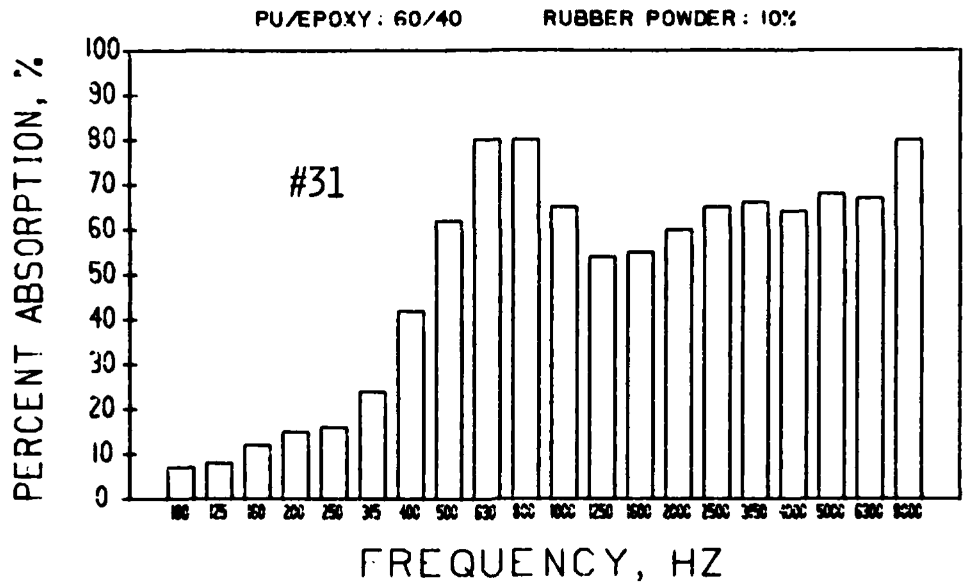

PU/EPOXY : 50/50 GRAPHITE : 10%
#26
PERCENT ABSORPTION, %
0
10
20
30
40
50
60
70
80
90
100
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

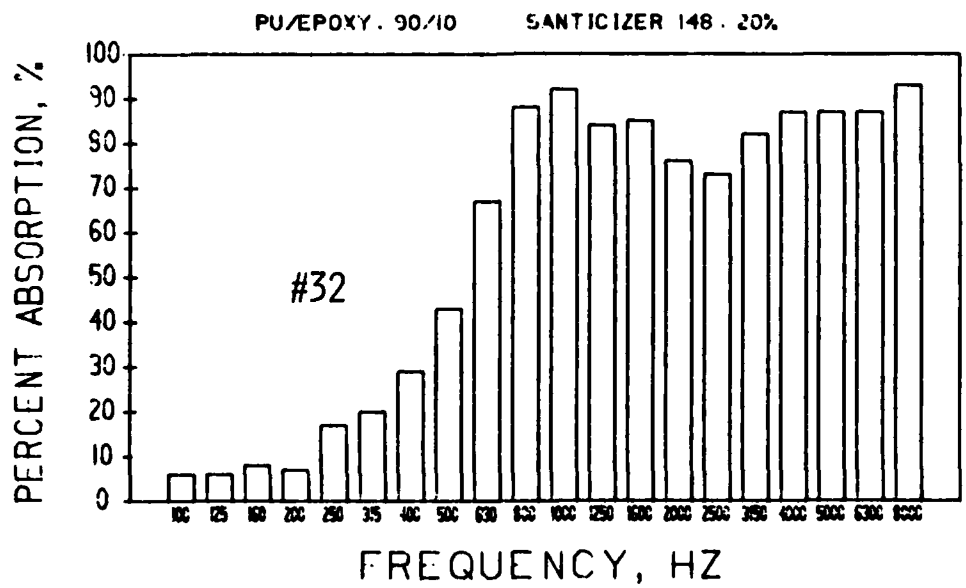


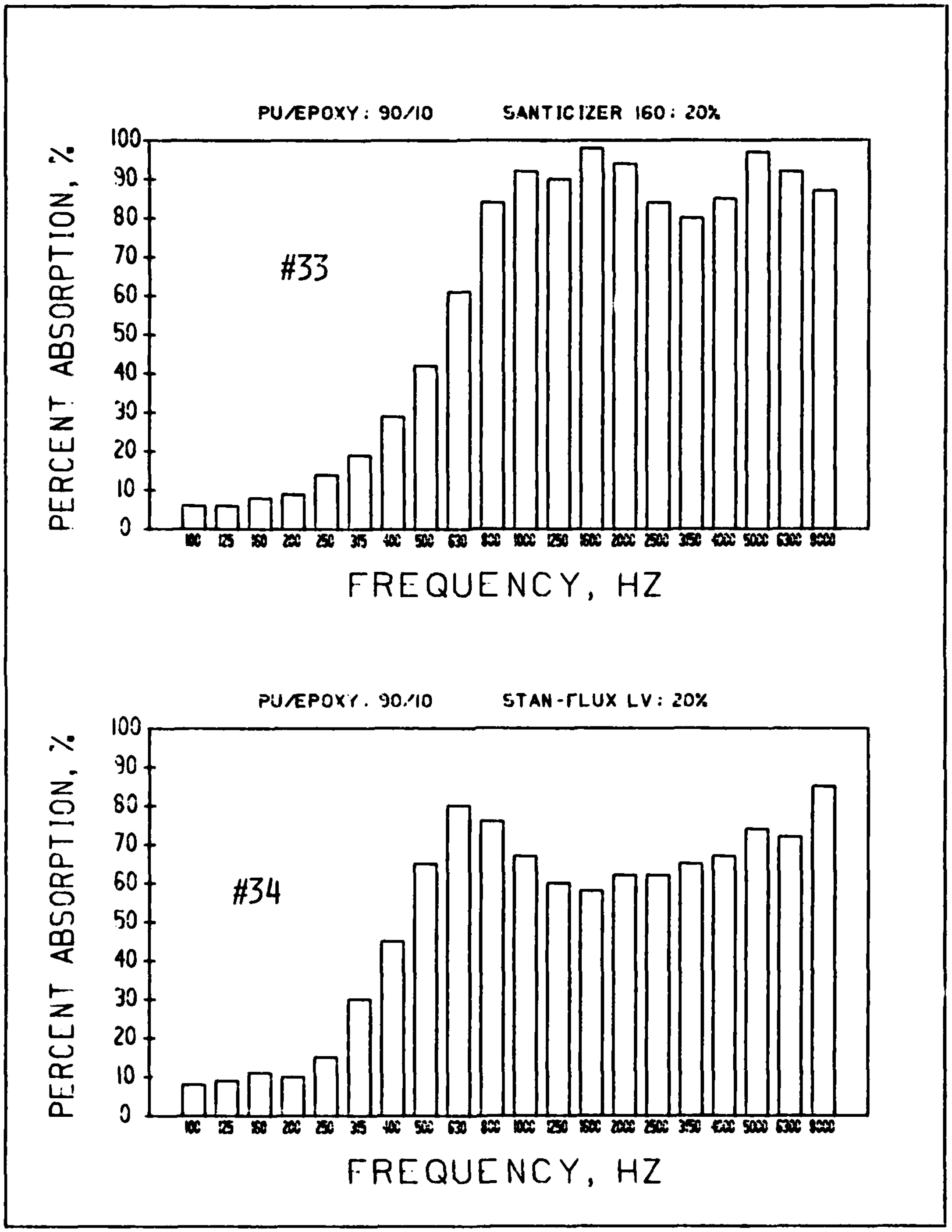
PU/EPOXY: 100/0
RUBBER POWDER: 10%
#27
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
FREQUENCY, HZ
PU/EPOXY: 90/10
RUBBER POWDER: 10%
#28
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
FREQUENCY, HZ

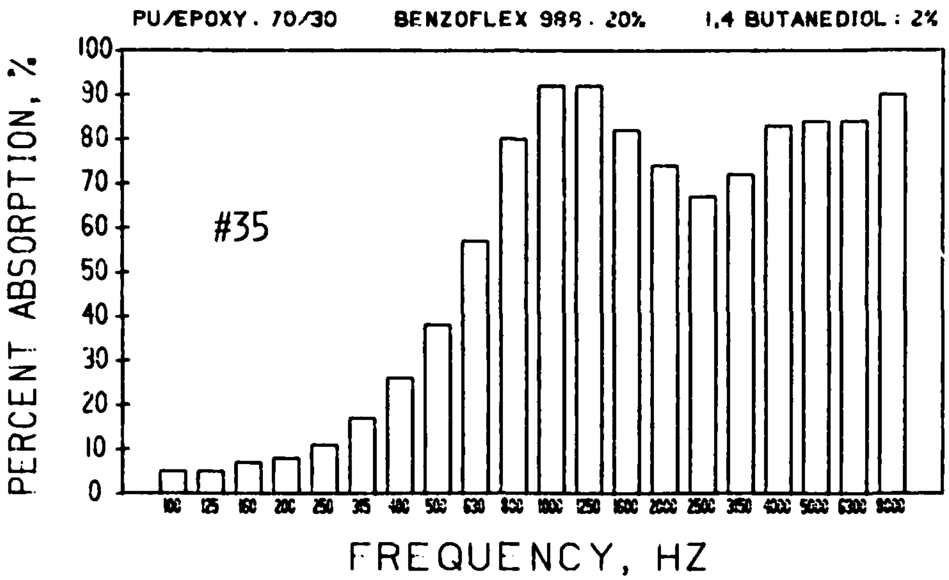

PU/EPOXY: 80/20
RUBBER POWDER: 10%
PERCENT ABSORPTION, %
FREQUENCY, HZ
#29
100
90
80
70
60
50
40
30
20
10
0

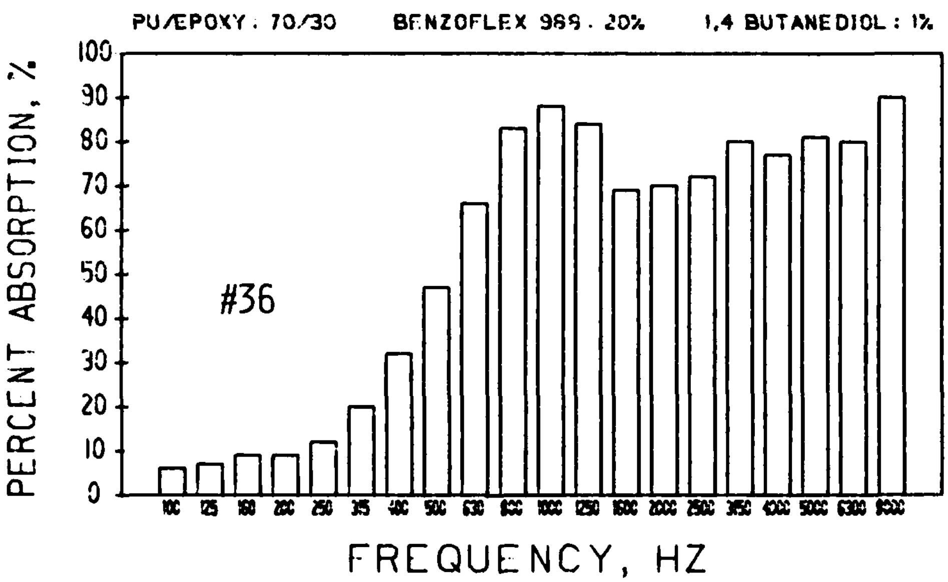

PU/EPOXY. 70/30
RUBBER POWDER. 10%
PERCENT ABSORPTION, %
FREQUENCY, HZ
#30
100
90
80
70
60
50
40
30
20
10
0

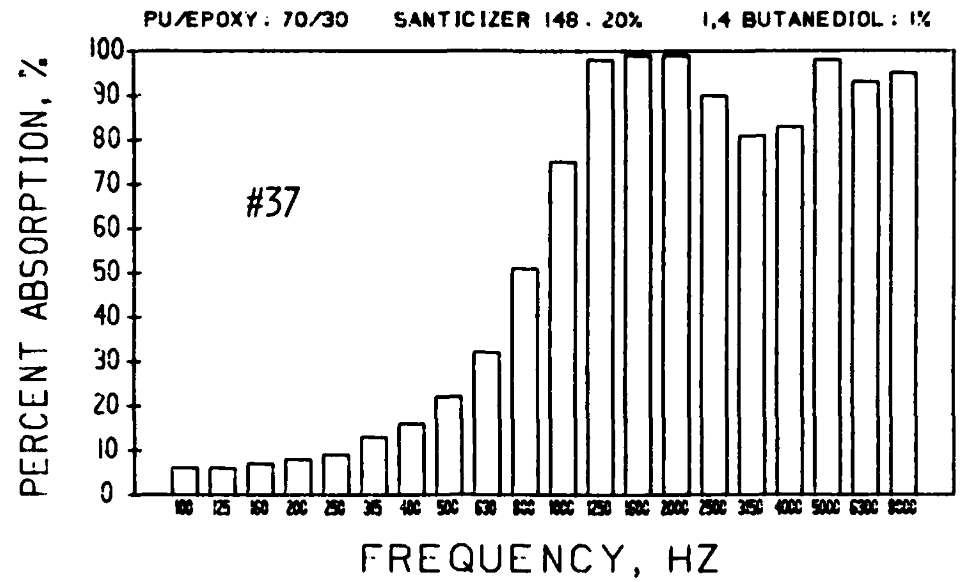

PU/EPOXY: 60/40
RUBBER POWDER: 10%
#31
PERCENT ABSORPTION, %
FREQUENCY, HZ

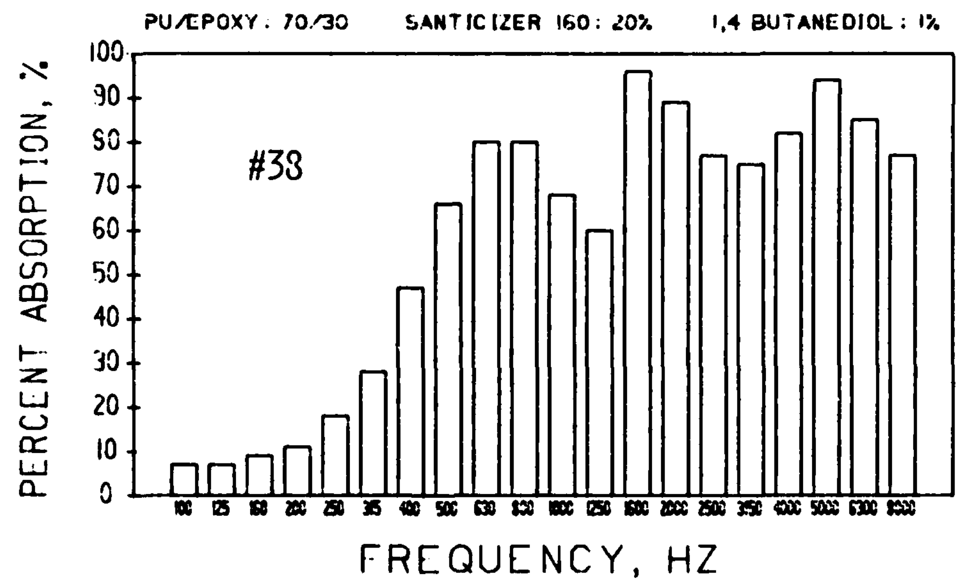

PU/EPOXY. 90/10
SANTICIZER 148. 20%
#32
PERCENT ABSORPTION, %
FREQUENCY, HZ

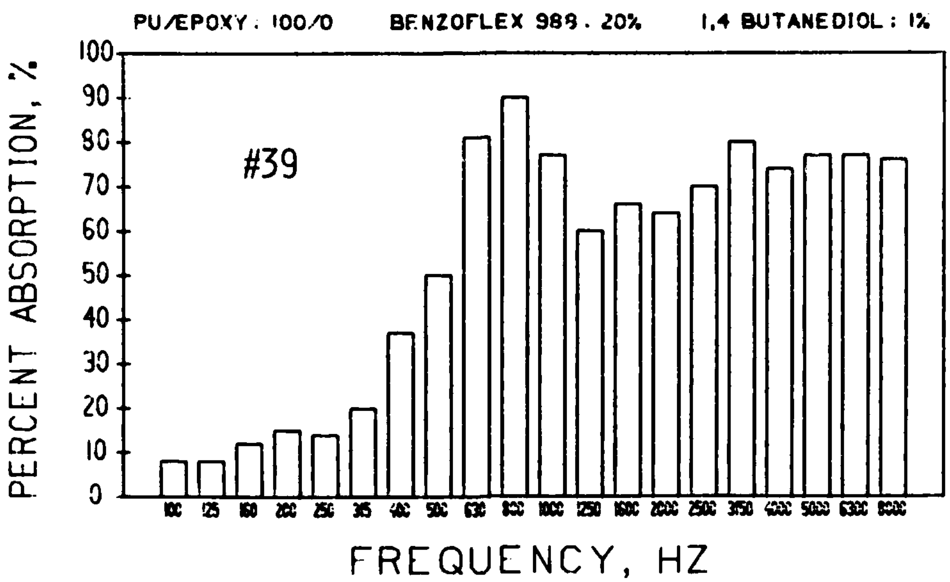

PU/EPOXY: 90/10
SANTICIZER 160: 20%
PERCENT ABSORPTION, %
#33
FREQUENCY, HZ
PU/EPOXY. 90/10
STAN-FLUX LV: 20%
PERCENT ABSORPTION, %
#34
FREQUENCY, HZ


PU/EPOXY. 70/30
BENZOFLEX 988. 20%
1,4 BUTANEDIOL: 2%
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
#35
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

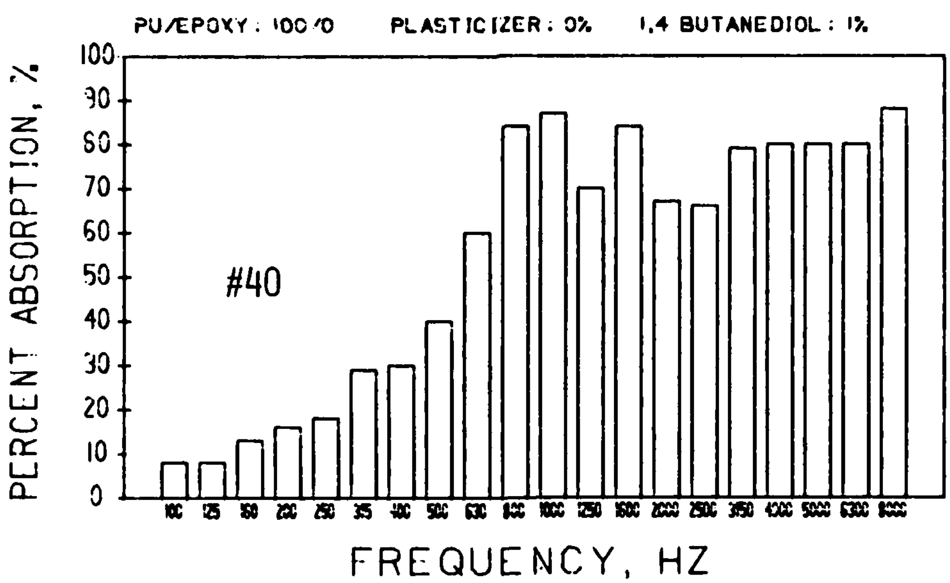

PU/EPOXY: 70/30
BENZOFLEX 988. 20%
1,4 BUTANEDIOL: 1%
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
#36
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ


PU/EPOXY: 70/30 SANTICIZER 148: 20% 1,4 BUTANEDIOL: 1%
#37
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
FREQUENCY, HZ

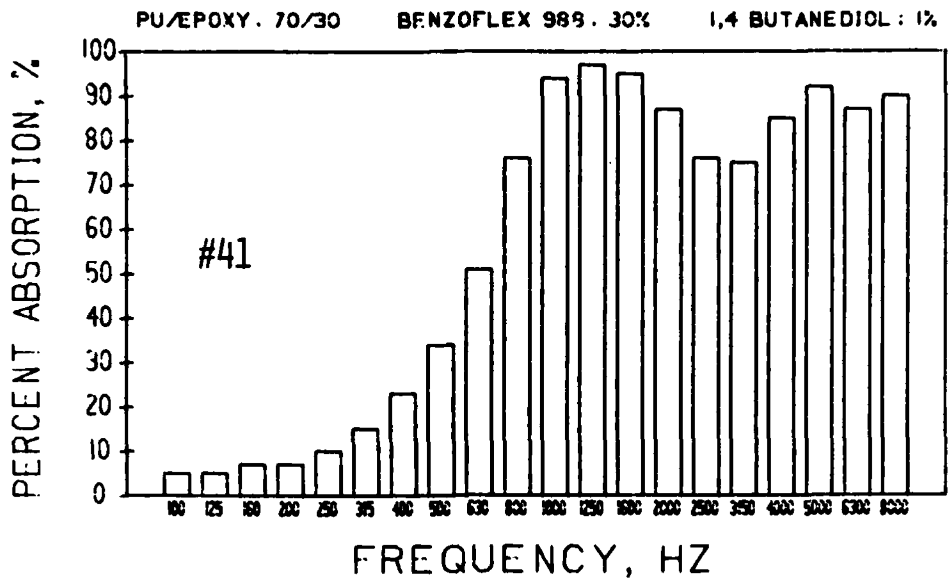

PU/EPOXY: 70/30 SANTICIZER 160: 20% 1,4 BUTANEDIOL: 1%
#38
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000
FREQUENCY, HZ

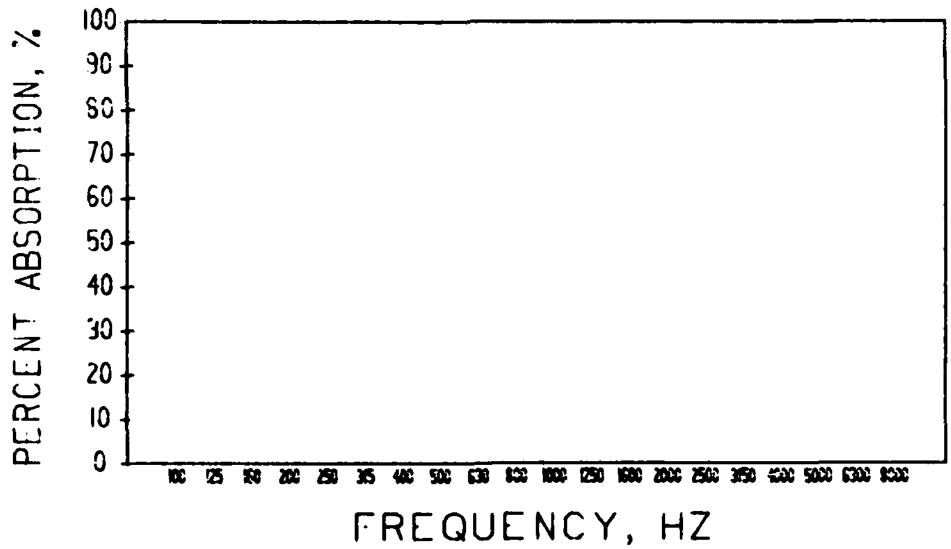


PU/EPOXY : 100/0
BENZOFLEX 988 . 20%
1,4 BUTANEDIOL : 1%
#39
PERCENT ABSORPTION, %
FREQUENCY, HZ



PU/EPOXY : 100/0
PLASTICIZER : 0%
1,4 BUTANEDIOL : 1%
#40
PERCENT ABSORPTION, %
FREQUENCY, HZ


PU/EPOXY. 70/30
BENZOFLEX 988. 30%
1,4 BUTANEDIOL : 1%
PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
#41
FREQUENCY, HZ


PERCENT ABSORPTION, %
100
90
80
70
60
50
40
30
20
10
0
FREQUENCY, HZ

END

11-86

DTIC